Aalto-yliopisto
Insinööritieteiden
korkeakoulu

Otto Pesola

Differences between real estate maintenance costs in Scandinavia, Middle East, China and Spain - The savings potential through facility management software

Diplomityö, joka on jätetty opinnäytteenä tarkastettavaksi diplomi-insinöörin tutkintoa varten.

Espoossa 16.10.2017
Valvoja: Professori, TkT Seppo Junnila
Ohjaaja: DI & KTM Topi Korpela

Aalto University
School of Engineering

Aalto-yliopisto, PL 11000, 00076 AALTO
www.aalto.fi

Diplomityön tiivistelmä

Tekijä Otto Santeri Pesola		
Työn nimi Kiinteistöjen ylläpitokustannusten erot Skandinaviassa, Lähi-idässä, Kiinassa ja Espanjassa – kiinteistöjen ylläpito-ohjelmistojen säästöpotentiaali		
Koulutusohjelma Kiinteistötalous		
Pää-/sivuaine Kiinteistöjohtaminen / Maankäytön suunnittelu		**Koodi** M3003
Työn valvoja TkT Seppo Junnila		
Työn ohjaaja(t) Diplomi-insinööri, kauppatieteiden maisteri Topi Korpela		
Päivämäärä pp.kk.vvvv	**Sivumäärä** 56+6	**Kieli** englanti

Tiivistelmä

Kiinteistöistä aiheutuu 40 % kaikesta energiankulutuksesta ja 30 % kaikista päästöistä EUssa ja sen lisäksi Suomessa 70 % bruttokansantuotteesta on kiinni kiinteistöstä. Suomessa myös ylläpitokustannukset ovat nousseet 19 % viimeisen viiden vuoden aikana, joten niiden sosioekonominen vaikutus on huomattava.

Tämän tutkimuksen tavoitteena oli selvittää, miten ylläpitokustannukset eroavat toisistaan Skandinaviassa, Lähi-idässä, Kiinassa ja Espanjassa, miten kiinteistöomistajat käyttävät kiinteistöjen ylläpito-ohjelmistoja ja minkälaisia säästöjä ja etuja he niistä saavat.

Teoriaosuus keskittyy ylläpidon konseptiin, kiinteistökohteiden johtamiseen, toimitilajohtamiseen, kestävään kehitykseen ja sen sertifikaatteihin, sekä mistä ylläpitokustannukset koostuvat ja miten niitä analysoidaan. Empiirisessä osiossa analysoidaan eri maiden ylläpitokustannuksia ja niiden eroja, niin kustannusten kuin maidenkin. Haastattelututkimuksessa haastateltiin viittä eri yritystä, jotka käyttävät kiinteistöjen ylläpito-ohjelmistoja päivittäin. Heiltä kysyttiin sen eri prosessien käytöstä, millaisia säästöjä he ovat saaneet siitä, millaista lisäarvoa ne tuottavat heille, kuinka he käyttävät mobiiliaplikaatioita ja miten he näkevät tulevaisuuden kehityksen.

Tuloksena Euroopan valtioiden ylläpitokustannukset ovat keskenään melko linjassa, siinä missä Kiinassa ne ovat huomattavasti korkeammat. Haastattelututkimuksen perusteella voidaan todeta, että yritysten energiankulutus tippuu käyttämällä ylläpito-ohjelmistoja ja niiden tuottamaa dataa, mutta johtuen mittaustietojen puutteesta tarkkoja laskelmia tästä ei saatu, kuten ei myöskään kustannussäästöistä. Yritykset käyttivät huoltosuunnitelmaa, palvelupyyntöjä, pitkän tähtäimen suunnitelmaa ja energiamittarointia, mitkä myös hyödyttivät heitä kaikista eniten. Tarkka raportointi, tehostunut työskentely ja mobiilisuus nähtiin suurimmiksi eduiksi ja lisäarvon tuottajiksi, ja kehityksen nähtiin menevän myös tähän suuntaan.

Avainsanat kiinteistökohteen johtaminen, toimitilajohtaminen, kiinteistöjen ylläpitokustannukset, ohjelmistokehitys

Author Otto Santeri Pesola

Title of thesis Differences between real estate maintenance costs in Scandinavia, Middle East, China and Spain - The savings potential through facility management software

Degree programme Real Estate Economics

Major/minor Real Estate Management / Land Use Planning **Code** M3003

Thesis supervisor D. Sc. (tech) Seppo Junnila

Thesis advisor(s) M.Sc. (tech) Topi Korpela

Date dd.mm.yyyy **Number of pages** 54+3 **Language** english

Abstract

Real estates account for 40 % of energy consumption and 30 % of emissions in EU and it covers 70 % of nations GDP in Finland. Real estate maintenance costs have risen over 19 % in the past five years in Finland and maintaining them has a huge socioeconomical impact.

The object of this research was to find out how maintenance costs differ in Scandinavia, Middle East, China and Spain, how real estate owners uses computerized maintenance management software and what kind of savings, both in cost and energy, do they obtain in it.

The theory part focuses on the concept of maintenance, facility management and sustainability and its certificates, in addition with how maintenance costs are analysed and where do they consist of. In the empirical part of the study different maintenance costs from the target countries are analysed in addition with their differences. The interview study was done by interviewing five different companies that use facility management software regularly. They were asked how they use it, what kind of savings have they obtained from it, what kind of added value do they get from it, how do they use mobile applications and see the future development.

As a result, European countries had similar maintenance costs, where as China's prime market costs were way above them. Companies obtained energy savings from using CMMS in addition with other cost savings, and they constantly use maintenance audits, long term planning, maintenance planning and energy metering, which also gave them biggest added value. Accurate reporting, more efficient working and mobility were seen as the greatest advantages, and they thought that remote monitoring, real time data and mobile applications were the way that development is going in the future.

Keywords Property Management, facility management, real estate maintenance costs, Service as a Software

Alkusanat

Lähtölaukaus tälle diplomityölle saatiin jo vuoden päivät sitten, mutta vihdoin ja viimein urholliset ponnistukset ovat saaneet sen maaliin. Haluaisin ennen kaikkea kiittää ohjaajaani Topi Korpelaa sekä valvojaani Seppo Junnilaa alituisesta ja pyyteettömästä liidaamisesta ja avusta tässä projektissa, ilman teitä työsarkani olisi ollut paljon apaattisempi. Samalla haluaisin kiittää koko Granlund Oy:tä, erityisesti suuren suuren avun antaneita Veikko Martiskaista ja Aki Wickmania jotka ovat sparanneet minua läpi tämän projektin, samaten tukien ja antaneet neuvoja ankeimmilla hetkillä. Samaten haluan kiittä TEKESiä projektin rahoituksesta.

Pitkän ja kivisen tien varrella on ollut toki muitakin kultaisia ihmisiä ja tuttuja ja ilman teitä kaikkia tämä kuusi vuotta kestänyt opiskeluksikin välillä kutsuttu projekti olisi ollut enemmän kuin tylsä, siksi onkin asiallista, ellei peräti kunnollista kiittää kaikkia teitä matkan varrella olleita ystäviä. Ilman niitä pitkiä, unettomia öitä Hissin konehuoneessa, Kirjastolla, kiltiksellä, Maarilla tais ties missä paikoissa, ei tätäkään taivalta olisi loppuun saatettu, mutta onneksi useimmiten matkalla on ollut ystäviä, kuten MKH'13 ja MKH'14, oma rakas nöpöneniä täynnä oleva PTK'16, X-määrä muita nuijia, Hankkijoita, nohevia saunanrakentelijoita ja paljuautonhitsaajia, jo Olarista lähtien olevia elinikäisiä kavereita sekä tietysti vierustovereita istumassa niin työpisteellä kuin ikuisuudelta tuntuneen ajan pääkirjastossa näpyttäneitä kohtalontovereita. Lisäksi en voi tarpeeksi kiittää äitiä, isää, Ainoa ja Simoa näistä kaikista lämpimistä vuosista, mitä olen saanut kanssanne kokea nyt ja tulevaisuudessa. Annoitte minulle mitä mahtavimmat eväät elämään, kiitos siitä.

Tämä oli tässä, minä aion jatkaa pitkää ja kivistä tietäni vapaana ja omalla omintakeisella kielelläni, vieköötse minut sitten minnekin, vaikkapa suolakaivoksista Luxemburgiin.

Helsinki 16.10.2017

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Otto Pesola

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Abbreviations and descriptions

AM	Asset management
FM	Facility management
PM	Property management
SaaS	Service as a Software

Tables and figures

1 Introduction

From the total GDP (gross domestic product) of nation, real estate covers approximately 70 % of it, which also means that the emissions they cause over their life cycle. Therefore, it is vital optimize them in order to slow down global warming.

The overall maintenance costs have risen throughout the years, for example in Finland in the real estate maintenance cost index shows a 19 % rise in the last five years (Tilastokeskus, 2017). Real estate also accounts for 40 % of energy consumption and 30 % of emissions in the EU (INREV, 2015). Therefore, energy efficiency has risen as a crucial factor that all the player's in the real estate field do consider.

Computerized maintenance management software is a relatively new business, although they have been used for over 20 years professionally. Their function is to systematize real estate maintenance and thus to lower costs and structure maintenance, in addition providing important data about buildings. They can be seen as a solution regarding the rising consumption and deterioration of buildings. But to analyze energy savings and measure them, one must need to know what they are, from which parts do they consist of and how they are measured, in order to compare them, and analyze properly, if computerized maintenance management software really can solve these problems, and if they can, does it have any significant effect.

This thesis tries to throw light on how computerized maintenance management software function, how maintenance costs differ in different countries and why and what kind of advantages and savings can computerized maintenance management software cause. Neither these cost savings have not been analyzed earlier, nor how they differ in selected countries, which formed a basis for this research.

1.1 Problem background

This master's thesis is done as an assignment to Granlund, which is Finland's leading building service, real estate-, energy- and environment consultant, and software's regarding to them, specialist concern. Granlund has deeply focused to energy efficiency in all their specialism fields. Currently Granlund has 20 offices in Finland and the main office resides in Helsinki. Granlund employs over 700 specialists, from which over 350 work in the head office.

This thesis reviews real estate maintenance costs in different locations, their differences and what kind of savings can facility management software's create in them. It does not comment the different principles that these countries have in their property management, but instead puts them on a comparable level, reviews their different cost structure and energy consumption differences.

1.2 Research objective

The objective for this research is to review the differences of administration and maintenance costs of real estates in different locations and how the computerized maintenance management software could generate savings in these different segments.

1.3 Research questions

Research question 1:
How the real estate maintenance costs vary in Scandinavia, Middle East, Spain and China?

Research question 2:
What kind of savings the computerized maintenance management software can cause to maintenance costs in the selected markets?

Research question 3:
What features do real estate owners seem to value in facility management software?

1.4 Delimitations

The scope of this research was limited geographically to Shanghai/Peking in China, Abu Dhabi/Dubai/Oman in Middle East, Madrid in Spain and the capital cities of Finland, Sweden, Norway and Denmark as for the part of Scandinavian countries. Real estate administration and maintenance costs were delimited to only prime office buildings.

1.5 Research methods and material

For the theory part information is gathered from scientific articles that are related to the master's thesis subject. The scientific material consists mainly from articles, which are available in Google Scholar -database, Aalto University's library's and e-library's articles and material that is provided by Granlund and other cooperation companies. In addition, at regular meetings at Granlund, the progression of the research shall be guided if needed.

This research is both quantitative and qualitative. The quantitative aspect comes from researched and collected data, that were used to analyze the differences of maintenance costs in different regions. The qualitative analysis was done via theme interviews, to get to know the savings potential of facility management software and in which different ways they benefit their user companies. By researching the information, articles and results from the interviewees, a comprehensive overall picture may be formed from the studied are. The target is to gather phenomena and concepts, that are crucial to the study. Hirsjärvi et al (2006) stated, that essential features regarding qualitative analysis is that it is comprehensive information control. Human contact and discussion is strongly adviced to generate own perceptions. Hirsjärvi et al strongly recommend different research methods, such as theme interviews, so the interviewees opinions pop out. However, the interview group must be appropriate, and not be chosen via random sample. The function of qualitative analysis is not to test any theories, but to versatilely analyze material, and the researcher then decides, what is important and what is not. (Hirsjärvi et al. 2006. P. 157-160)

For this research 5 different interviewees were interviewed. The personnel were chosen by two points: they use daily computerized maintenance management software, and that they also know how they affect to their company's effectiveness, how the board uses such data and what kind of benefits both the board and their service companies get from mentioned software. Theme interviews mission was to find out what kind of benefits do computerized maintenance management software give to companies, how to they save energy and costs, what functions do they use in such software and what future trends they see in the field.

1.6 Terminology and key concepts

This thesis includes with many key terms, which are repeated throughout the thesis. These kinds of key terms are for example real estate and premise

Real estate or real property is a unit of ownership for a land or water area, including buildings, benefits and easements, registered in the land register (RAKLI 2012, p.10).

Facility management means real estate management, whose purpose is to manage the acquisition and development of facilities, as well as facility services and user services (RAKLI 2012, p. 17).

Property management means real estate management, whose purpose is to control the usability and value development of certain real estate or its part by taking into account the interests and needs of the real estate owner. (RAKLI, 2012)

Real estate maintenance is described as services for maintaining the condition, value, qualities and state of real estate at the desired level. (RAKLI, 2012)

Long term planning (proposal) means the actions for repairs and replacements for a certain time frame, which considers the technical aspects (RAKLI, 2012)

Service as a Software (SaaS) describes when users 'rent' or borrow online software instead of actually purchasing and installing it on their own computers. (Gil, 2016)

1.7 Structure of the research

This thesis consists of theoretical and empirical parts. In the research's second, third and fourth chapter the theoretical framework is familiarized whereas also an in-depth-analysis is made from maintenance costs, facility and property management and their different sections (chapter 2). The third chapter focuses on facility management software, their basics and their primary functions and with kind of added value they create. In fourth chapter, the maintenance costs in chosen locations are analyzed, in addition with analyzing the real estate markets in them. The fifth chapter is an empiric chapter, where an interview study was made to gather information about the energy saving strategies in the future and how facility management software can make additional savings and added value to real estate owners. Sixth chapter the results gathered from the interview survey. Seventh chapter argues about

the validity and reliability of the research. Chapter eight presents the conclusion of the research.

2 Real estate maintenance

This chapter reviews the different aspects that create the overall real estate maintenance and management, what do they consist of and what are the key parts in them. It also reviews the different type of energy costs that are addressed to buildings, how they are measured and what kind of costs they cause in the measuring period. In addition, this chapter analyses the different segments that create the maintenance costs in real estate, what they consist of and how they are measured.

2.1 Maintenance

In society, there are lots of different processes that provide different kinds of commodities. What they have in common is that they alter over time: they wear out and thus they start to malfunction. These processes can be found in all sectors of society, which means that there is a great need for maintenance (Järviö et al 2012, p. 11-14). The official definition of maintenance can be found in the European Union's SFS-EN 13306:2010 standard, which defines maintenance as "combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function"

In general, maintenance has been considered as repairing the malfunctions, but in today's constantly changing world, this definition is too narrow: it can be considered more as maintaining the productivity of the desired feature. There are different styles to divide the maintenance process, but the SFS generalizes it as following, which is shown in figure 1:

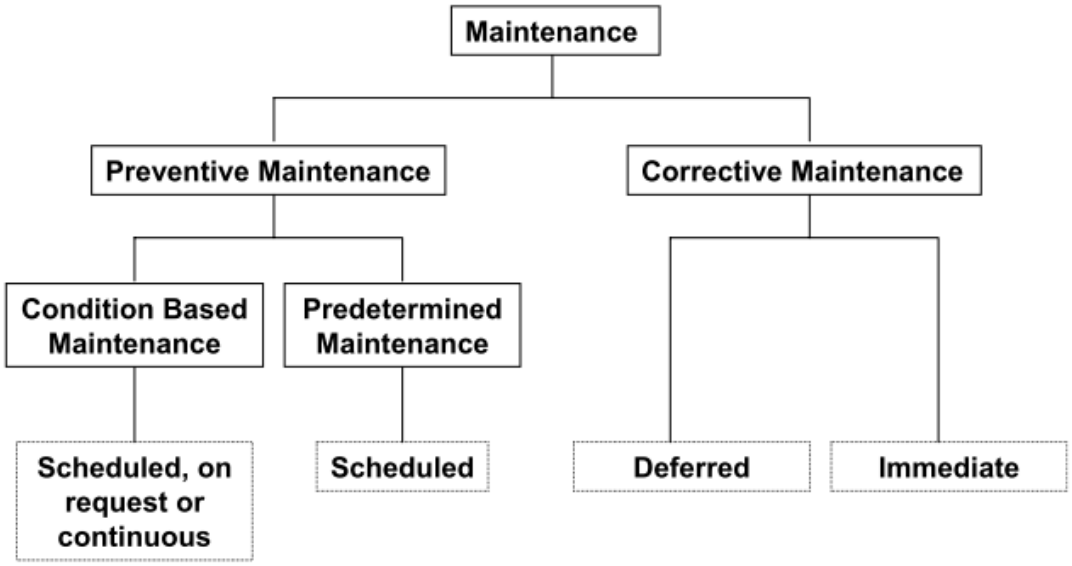

Figure 1: Maintenance and maintenance subcategories (SFS, 2010)

Corrective maintenance (or breakdown) is the classic, simplest type of classical maintenance. It's a policy where an item is used until it breaks or faults and the only activity is to repair it and service the new parts. It can be subdivided whether it is done immediately

or scheduled to a later date. It can also be included to a longer maintenance plan. (Lind & Myingo, p.15)

Preventive (or planned) maintenance refers to cases, when the repair or replacement takes place without any specific fault. It is meant to prevent failures, as the name suggests. In many models, the system is assumed to be as good as new after each maintenance. The more realistic situation, however, is that it is somewhere between perfect condition and awful condition. The preventive maintenance is usually subdivided into condition-based maintenance or time-based maintenance. In condition-based maintenance, the object is inspected on a regular based and then replaced or serviced, when a certain condition is observed. Time-based maintenance, on the other hand, does servicing/replacing to the object on a regular passage of time, regardless of the actual condition of the item. (Lind & Myingo, p. 16-17).

Lind and Myingo also present a new concept, opportunistic maintenance. This method covers the case where various things are done before there arises an opportunity to carry out a certain method. This makes the method more cost-effective versus the others, because when repairing an item, there might arise a situation where one can carry out corrective maintenance to another, previously undetected failing item. Therefore, it is possible to reschedule the specific action and take advantage of scale economies in the activity. (Lind & Myingo, p. 17).

2.1.1 Facility management

Facility management (FM), is a fairly new business and a management discipline to private sector. However, it has been practiced in the public as post engineering or in public works way longer. The recent definition, according to Cotts, Roper and Payant (2009), is "a profession that encompasses multiple disciplines to ensure functionality of the build environment by integrating people, place, process and technology". This newest definition highlights technology, which refers to the risen importance of it. In addition, security and emergency management has become much more important, in the USA for example due to 9/11. (Cotts, Roper & Payant, p. 4) As stated earlier, RAKLI defines FM as real estate management, whose purpose is to manage the acquisition and development of facilities, as well as facility services and user services (RAKLI 2012, p. 17). International facility Management Association IFMA describes it as (Facility management is a profession that encompasses multiple disciplines to ensure built environment with integration of people, places, processes and technologies." (Poór 2014, p.1)

Facility management embraces the concepts of cost-effectiveness, productivity, improvement, efficiency, and employee's quality of life. Usually, these concepts conflict with each other. For example, a bad air-quality in an office usually interferes with the quality of life. Therefore, a good facility manager is a good reactive manager. This may also cause problems, because therefore planning cannot be taken into account, although it is the key to cost-effectiveness (Cotts, Roper & Payant, p. 10). Facility management deals with support activities and their management whereas reducing the overhead costs that incur in different activities. Basically, facility management controls the interaction between processes, places and people, as figure 2 below shows.

Figure 2: Figure 2: The three P's of Facility management (Poór 2010)

Figure shows 2 sections that intersect and they represent the basic factors that interact, which facility management is basically about: integration between employees, their work and the working environment. Peter Poór describes facility management aims to "strengthen the organization processes by which work and workers serve the best performance and ultimately contribute positively to economic growth and overall success of the organization."

Skilled facility managers are needed specially to meet the goals that the owners have set, mainly in energy efficiency. Therefore, skilled facility managers need the following core competencies according to IFMA:

- Operations and maintenance
- Real estate
- Human and environmental factors
- Planning and project management
- Leadership and management
- Finance
- Quality assessment and innovation
- Communication
- Technology

In addition, with these competences environmental stewardship and sustainability and human and environmental emergency preparedness are important.

Facility management started getting its shape in the 80's, when professional with diverse backgrounds were organized into professional associations in the USA. Historically, facility managers can be thought as caretakers, project handlers, controllers, naysayers etc. These attributes are not all bad, but in changing world the facility managers need to adjust. The trends are the biggest game changers in the FM, such as focus on shareholder value, globalization, outsourcing, and growth of e-commerce, emphasis on speed and security preparedness. In the same time the population is aging, environmental concerns are a huge problem and the workforce has become increasingly diverse.

2.1.2 Property management

Property management (PM) means real estate management, whose purpose is to control the usability and value development of a certain real estate or its part by considering the interests and needs of the real estate owner (RAKLI 2012). Successful property management is a

demanding activity, which requires technical and organizational skills in addition with understanding of the field. (Scarrett et al 1995, p. 12) Scarrett defines property management that it "seeks to advise on the establishment of an appropriate framework within which to oversee property holdings to achieve the agreed short – and long-term objectives of the estate owner and particularly to have regard to the purpose for which the estate is held." These basic needs include negotiating lettings and rent, overseeing physical maintenance and the enforcement of lease covenants. They will take place in within the company's agreed strategy, which includes upgrading interest, recognizing other opportunities and developing the assets. (Scarrett et al 1995, p. 13) The main target is to maximize the net return whilst preserving and enhancing the capital value. The property management task is not repetitive and predictable as for example production line in a factory. Of course, there are recurring tasks that require routine manners, but because of the unique nature of property, each case can vary a lot. (Scarrett et al 1995, p. 13)

Property management is always related to one specific property, not a whole portfolio. It consists of mainly taking care of the technic, economic and organizational processes, including the responsibilities of renting the property and its vacancy. Kyle et al divide property managers' tasks into several different positions: as an economist, as a community member and as a facilitator of owner's interests. The economist-part means that the manager has to have comprehensive forces that surround and move the real estate market. One must have to evaluate the real estate in terms of operating income, forecast the future and thus construct a management plan to both reflect the owner's plan and that it can adapt to future changes. Other valid specializations include tenant psychology, space marketing and maintenance procedures. (Kyle et al, 2000, p. 13)

As an involved community member, manager should take interest in professional, social and political organizations in their municipality. Then the manager could boost local business opportunities by activing oneself in decision making and thus help to implement long term plans. Lastly the property manager is the facilitator to property owner's interests and must work within the guidelines, strategies and objectives of the owner. Manager must know what the owner wants to achieve in order to succeed in one's position. Usually this means maximizing the profits and preserving the value of the property. Occasionally the owner might hire the manager just to rip out every penny from the property. This approach might not be admitted but is usually spotted when the owner demands frequent payments and refuses to make any repairs other than necessary. In this situation, the manager should meet with the owner and pinpoint the possible losses that can occur if this strategy holds up. (Kyle et al 2000, p. 13)

2.1.3 Long term planning and renovations

In order to systematically, economically and technically maintain the condition of real estate, one must have a reliable information about the condition of the real estate and a prediction about the upcoming renovations, their timing and costs. In the long run, programmed maintenance also brings cost savings to the owner and the holder of the real estate.

The main target in the condition assessment is to gather an overall picture of the real estate and the surroundings of the building. The objective is not to specify the required actions of the repairs and renovations, but to gather the source information for long term planning. The report presents the condition of the structure and the machinery. The report also presents the

long-term plan for renovations and repairs. According to the report, the quarter who made the order decides if there is need for additional research and the desired maintenance plan. First, the urgent repairs are done according to the report. After that, the additional researches are done if they are needed to complete the maintenance plan. Figure 3 below shows the economic life cycle of a property:

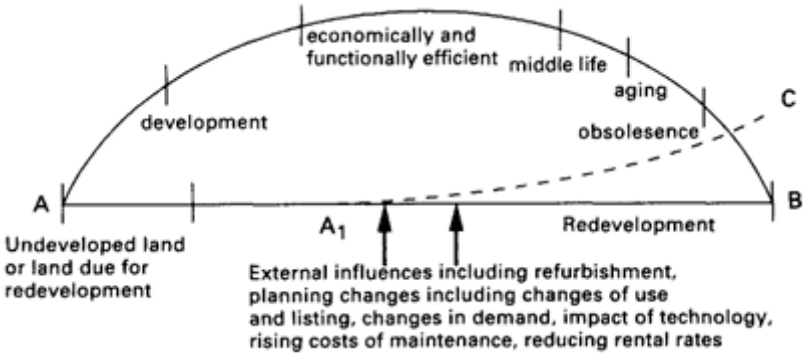

Figure 3: Economic life cycle of property (Scarrett et al 1995, p. 35)

The condition assessment covers the following, essential parts of the building and its surroundings:

- Outdoor areas and the surface
- Structures
- HVAC and automation systems
- Electricity, tele and IT-systems
- Energy efficiency
- Indoor conditions

The different stages to perform a condition assessment are:

- Planning the condition assessment and its structure
- Collecting and analyzing the source information
- Performing a user survey
- The site inspection
- Reporting the results

In depth, the condition assessment answers to the following issues:

- Urgent repair needs
- The short-term repair and renovation needs for structures and systems
- Grand renovation and improvement needs
- The most significant damage risks of the structure and systems relating to building's safety and healthiness
- Energy and water consumption according to the material provided by the orderer
- Other energy economical findings and recommended actions related to them
- Usage of the building and the knowledge of the real estate manager
- Problems according to user survey
- Maintenance history and renovations according to the employees and documents
- The overall condition of the building compared to other equivalent buildings

The condition assessment also figures out the order of importance of the different actions regarding the building. Primary concerns are the ones regarding the safety and health, whereas in second comes repairs that concern the most significant damages. Damages, when getting worse that pose significant damage and cost risks are also equally important. In addition to the previously mentioned actions, statements about the functionality, comfortability and convertibility of the building can also be made, but this must be done in collaboration with the order maker: the different spaces, their volume and also to specify the things that are checked in the process.

Condition assessment can also be made to a specific structure or system. Then the process is called horizontal conditional assessment. Elevators or special machinery is not included in the condition assessment. There is still a chance that hidden damages may not be found in the condition survey. However, different damage processes are assessed in the process and therefore further investigations may be recommended.

Condition assessment shouldn't be mixed with condition survey. Condition survey is an in-depth survey of building and its machinery in order to evaluate the life cycle phase of the building and the necessary as well as any need of repair planning (RAKLI 2012, p. 38). In condition survey, destructive methods may be used. For example, moisture damage may be determined by removing tiles (RAKLI 2012, p. 38). Different kind of condition surveys are indoor climatic condition survey, water supply and sewer fittings survey, and condition survey of buildings damaged by moisture and mold (RAKLI 2012, p. 38).

Condition survey consists of the following steps:

- Checking the condition assessment report
- Performing the necessary condition surveys
- Complementing the condition assessment report into long term plan
- Defining the maintenance charge

Long term plan proposal, or technical LTP, is a plan, which provides the framework where large repairs and replacements are done in the following years. It is updated yearly and it provides a repair plan for following years, for example ten years, where the first five years are planned more specifically. The survey report shows the condition surveyors' opinion of the condition of building, a structure, or an HPACA (heating, plumbing, air conditioning and automation) system. It provides the repair and renovation schedule for construction technology, HVAC-technology, electricity, elevators and building automation. (Järviö et al 2007)

2.2 Energy in real estate

This subchapter is about energy consumption in real estate, how it is measured and by what criterions and what different factors cause the overall consumption.

The role of built environment is huge when it is taken into global context: the ERA17 – report shows, that the energy used in buildings in construction and usage cover for 40% of end-use energy and 40% of greenhouse emissions. In addition to heating and electricity

buildings and their activities consume excessive amounts of water and they produce a vast amount of different waste (KTI, 2011, p.7).

Eco-efficiency and energy efficiency have become part of strategy in real estate companies and environment-related viewpoints are clearly the biggest section when considering social responsibility. ERA17-report states that the biggest objective with energy-efficiency is to reduce greenhouse emissions efficiently. Energy-efficiency means that with less is produced more whilst saving the environment. So, the objective is to use as little materials and energy and meanwhile lessen the environmental harmfulness over the whole life-cycle of the building (KTI 2011, p.7). The main target is to decrease energy consumption. There is a significant impact on the profitability of real estate business and thus the users have the economic interest to reduce consumption. Building emissions consist of heating and electricity and their electricity needs. (KTI 2011, p.17).

2.2.1 Electricity

Electricity is usually measured in kWh per square meters per month, in order to get comparable results from the overall electricity consumption. It can be divided into two parts, consumption that is caused by the real estate (lighting of common spaces, usage of different technical operations and systems) and the consumption that is caused by the occupier. The responsibility of these costs varies usually the real estate consumption and its costs are owners responsibility, whereas the user consumption is the occupier's responsibility. The separation between these two is not always expedient or even possible because of the lack of measuring devices. (KTI 2011, p. 24)

2.2.2 Water

Water usage is measured as cubes per square meters per month. The key figure for costs is measured by money per square meters per month. The usage of water is the central indicator regarding to water as a whole. Its usage varies between different types of buildings. In Finland, basically all used water is "clean water". Sewage water is also one instalment, but it isn't divided into different cleanliness categories. This is done due to the great investment costs needed to recycle and divide different types of water, that the advantages caused by it doesn't cover the vast expenses.

The used energy for heating the driving water is usually great proportion of the whole energy consumption, but usually – especially in old buildings – it cannot be separated from the rest of energy consumption. On the other hand, the heating energy from the heated driving water can be re-used, but this is an opportunity in buildings that use excessive amounts of water, for example laundries.

2.2.3 Heating and cooling

Heating and cooling is usually measured by kWh per square meters per month to get comparable results in between different building. Energy consumption regarding to heating and cooling is usually proportioned to building's area and velocity. In order to get space

utilization considered, these key figures should also be proportioned to the number of occupiers in building, it's utilization and lifespan. It is also important to specify the form of energy used in building, such as fossil fuels or renewable energy. (KTI 2011, p. 23)

2.3 Certificates and sustainability

Green buildings have become an increasingly relevant topic nowadays due to the pressure to lower emissions. Green buildings thrive to achieve economical, healthy and environmentally healthy construction, and green building certificates give the opportunity to measure and compare the greenness of a certain building with strict criteria (Rakennuslehti 2010).
In Finland, the movement towards building certificates has been relatively slow, due to beliefs that these certificates do not give enough yield to owners compared to their costs. Still, different researches show that via green construction the usage costs of the building can be lowered by 8 percentages, whereas the value of the building can increase from as much as 7,5 percentages and return of investment (ROI) rises 6,6 percentages (Rakennuslehti, 2010).

The most used certificates are LEED and BREEAM. LEED, or Leadership in Energy & Environmental Design is a green building certification program that is run by US Green Building Council. (www.usbgc.org, 2016). BREEAM, or Building research establishment environmental assessment method is the world's longest established green building assessment and certification, that is run by Building Research Establishment from UK (www.breeam.com, 2016).

2.3.1 LEED

As mentioned, LEED is a green building certification monitored by non-profit organization U.S. Green Building Council. It ensures electricity cost savings, lower carbon emissions and healthier environments for the places we live and work. LEED credits are awarded by third-party technical reviewers. They are also applicable to all building types throughout the building's lifecycle and they are developed through several rounds of public comments in collaboration with USGBC.

LEED projects do earn points from fulfilling different prerequisites and credits across nine measurements. These measurements include building excellence, integrative process and indoor environment quality. These credits in different fields go through several rounds of public comments in collaboration with the USGBC board. Because of the development of technology and market readiness, credits are meant to challenge and boost the value of building projects. Based on the number of credits achieved, the project might earn one of four LEED rating levels: LEED Certified, LEED Silver, LEED Gold and LEED Platinum.

LEED benefits building in many ways. It guarantees high performance of buildings, sets the market rates for commercial real estates in highly competitive markets and saves energy and resources, due to the factor that sustainability now rates as a key factor in market valuations. LEED also creates healthier work environments, which boosts the productivity in

workspaces. Because of the uniquity of the certificate, different buildings can also be compared across the globe. (www.usgbc.org, 2016).

2.3.2 BREEAM

BREEAM is an environmental standard that rates the sustainability of buildings in UK. Its main target is to minimize environmental impact by ensuring sustainability best practices whilst also lowering organizations' costs through energy efficiency. BREEAM has also been exported to other countries and it is not only used inside UK anymore.

BREAAM was created to mix cost-effectiveness with sustainable values and thus to help investors, developers and construction teams to use natural resources more efficiently. It uses recognized measures of performance, which are set against established benchmarks to evaluate building's specification, design, construction and use. The certificated assessment is delivered by a licensed organization. There are different kind of tailored rating tools so that BREAAM suits most types of buildings, for example BREAAM Ecohomes or BREAAM Education. BREAAM ratings range from Pass to Outstanding, which are shown in table 1. In order to achieve a particular rating, a series of mandatory minimum standards must be achieved. The key principles that are measured in BREAAM are

- Management – management policies, building commissioning and procedures
- Health and wellbeing – Indoor and external issues affecting health and the wellbeing of the occupants
- Energy – Operational energy and emissions of completed development
- Transport – Different transport and site access points
- Water Efficient water usage of building and tenant services
- Materials – Environmental implications of building materials
- Waste – Recycling and management of waste products during construction and in operation
- Land use and ecology – This factor encourages the use of brownfield sites and rehabilitation of contaminated lands
- Pollution – Reduction/Elimination of air, water and light pollution
- Innovation – Additional credits if actions significantly exceed BREEAM requirements

Rating	% Score
Outstanding	≥85
Excellent	≥70
Very good	≥55
Good	≥45
Pass	≥30

Table 1: Summary of required credit points for a rating in BREEAM (Mecserve.com, 2016)

The BREAAM rating is determined by weighted score of credit points in criterion that were earlier mentioned (Mecserve.com, 2016)

2.3.3 Value of sustainability

In recent years, it has been a rising trend to invest in sustainability to reduce the negative impact that built environment causes to our planet. Still, there has not been enough reasonable evidence what it causes to the value of the real estate. There is a serious lack of evidence between sustainability and market value and it has been somewhat of a barrier to block more larger investments. (Warren-Mayers 2012, p. 116) The limited number of sustainable properties might be the cause of inadequate information when solving the relationship and causality between sustainability and market value. Vimpari and Junnila (2014a) noticed, that globally renowned certificates raise the profits generated from real estate, for example LEED Platinum – sertificate increase market value by 8,8 %, and it increased through yield and rental income (Junnila et Vimpari, 2014 b). All the recent studies are normative, basically just proposals of how sustainability should work and affect the market value. The demonstrations have mainly been case studies with statistical models which have been used to identify the positive impact, but mainly they have been "how they should affect"-kind of analysis. Research in the field have widely been biased with its positive focus and limited critical assessment, which has led to limited certainty, clarity and validity of the field. Compelling business cases were developed by governments to justify investments to parties regarding the matter. Still, these practices have a solid aim: to gain market-wide adoption of sustainability practices. (Warren-Meyers 2012, p. 116-118)

For years, real estate market was limited with due to its skill to adopt into sustainable values, due to the vicious circle between different operators in the field (see figure 4 below).

Figure 4: Vicious circle of blame, (Warren-Meyers 2012, p. 119)

The figure above misses a crucial factor. Because the valuators work also as advisors to different players in the field, valuators play a crucial role in adapting these sustainable values into action. In 2008 Lorenz applied feedback to the vicious circle of blame and added the valuers and advisors there in order to demonstrate the positive effect that sustainability causes to the market. The figure also broadens the amount of professionals working on the

field, such as bankers and insurers, as figure 5 shows.

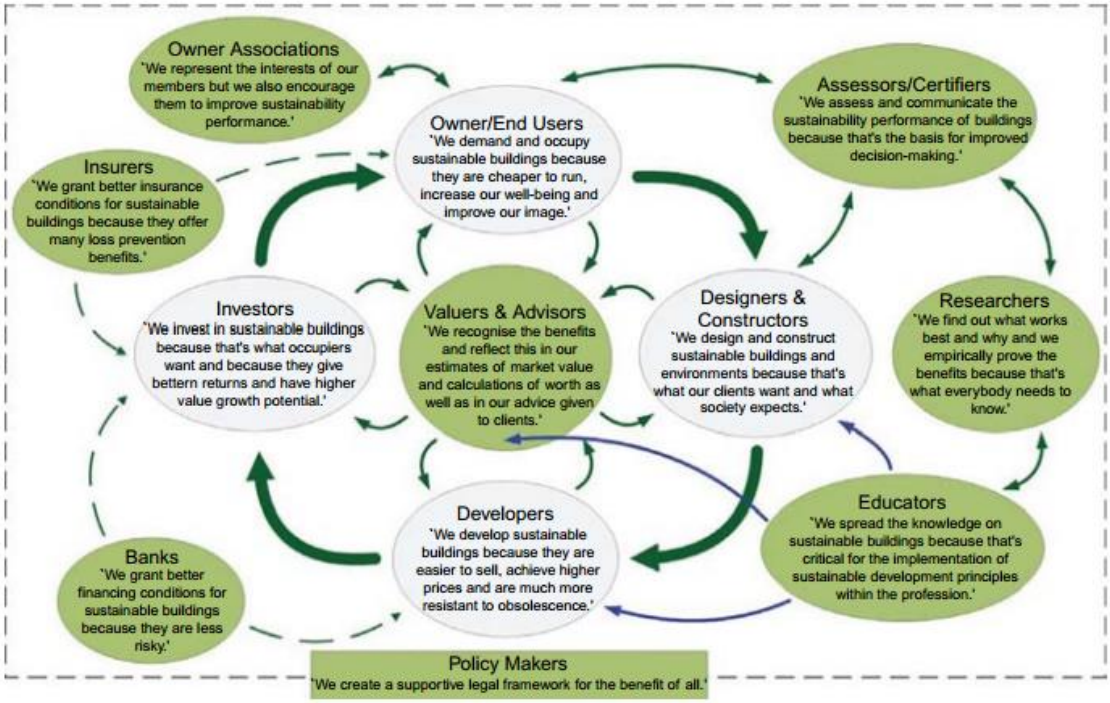

Figure 5: The broadened vicious circle of blame (Lorenz 2008)

JLL analyzed that between 2005 and 2007 sustainability increased the occupier's willingness to buy, but since 2008 it decreased it. This was caused by investors unwillingness to sacrifice profit for the sake of environment. This is caused by the uncertainty of added value in sustainability, which time has not answered. (Warren-Meyers 2012, p. 116-120)

Usually sustainability's value and its studies can be categorized into three fields: cost-benefit analysis or ratios, quantitative studies and valuation methodology simulations, which the latter has three subcategories: cost approach analysis, residual approach analysis and income approach analysis. In the recent years, it has moved away from quantitative studies to a more simulative approach. The relationship between sustainability and market value still seems complicated because of the different kind of approaches and advantages that it causes and its valuations. The advantages can be valuated through occupiers, rents or reduced operating costs. Although these valuations show advantages, they do not straightly implicate that inferences to market value. (Warren-Meyers 2012, p. 126)

2.4 Maintenance costs in real estate

The overall maintenance costs that a certain building causes consist from different items of expenditure. In Finland, the most common grouping of these different parts is from the book "Kiinteistöyhteisön tilipuite", which divides maintenance and upkeep costs into 13 different sections which also work as a foundation in this thesis. Usage and maintenance costs, outdoor maintenance costs and cleaning costs can be categorized into service costs, heating, electricity and water costs into energy costs and administration costs, waste disposal costs, insurance costs and other maintenance costs into other expenditure items. (KTI 2016, p. 4)

2.4.1 Administration

Administration costs consist of property's administration costs, personnel administration costs, office costs, such as office utensils, property management costs, other administration costs such as accounting costs, audit costs and other consulting costs that are bought. In addition, all IT costs, banking costs and advertising costs are allocated under administration costs. (KTI 2016, p. 4)

2.4.2 Usage and maintenance

In this item of expenditure all costs that are results from upkeep of the building or preserving the functionality of its machinery. These actions consist of minor changes, such as lamp changes, adjustments, refinements, inspections and minor maintenance works, such as oiling the machinery. In addition, costs from safety and consumption monitoring go under usage and maintenance costs. (KTI 2016, p. 4)

2.4.3 Outdoors

Outdoor maintenance costs consist of public sanitation (raking, waste collection), plant care, snow clearing and preventing slippery. Also, if there are winter upkeep agreements with the town, then those costs are allocated also here. (KTI 2016, p. 4)

2.4.4 Cleaning

Cleaning costs consist from payments that maintenance- or cleaning companies do inside the building that involve cleaning. These payments may come from window cleaning, changing carpets, material costs or from minor acquisitions. These cleaning costs regard the costs that are on owner's responsibility, which may vary a lot regarding on the contract. (KTI 2016, p. 4)

2.4.5 Heating

These costs are caused by the energy costs that are needed to warm the building. This means either costs from electricity, district heating or natural gas that is used to heat the building. (KTI 2016, p. 4)

2.4.6 Water and sewage water

This item of expenditure consists of costs that are results from water usage, both consumption water and sewage water, fixed charges of water, payments from usage, rents from meters and possible optional charger from sprinklers and sewage water processing. (KTI 2016, p. 4)

2.4.7 Electricity

This item of expenditure consists from all the electricity and gas payments that the building causes. In this case gas means stove gas. If electricity is used to heat the building, then the expenditures are enrolled into heating costs. In this case, the electricity costs contain from building electricity i.e. the electricity consumption that the tenant causes. (KTI 2016, p. 4)

2.4.8 Waste disposal

Waste disposal costs consist from payments that waste disposal companies charge. These charges consist of taking care of the waste and processing it, cleaning the waste bins and renting dumpsters. Also, the maintenance costs regarding them are included here. (KTI 2016, p. 5)

2.4.9 Insurance against loss or damage

All the insurance costs that are focused into the building are directed here, such as building insurance, fire insurance, construction insurance, machinery insurance and other insurances that are material specific. Deductibles are not part of these costs. (KTI 2016, p. 5)

2.4.10 Rents

This item of expenditure consists of rents paid from the plot and maintenance charges that the tenant pays from the areas surround, such as parking areas. They can also be allocated into specific functions, such as renting a waste press. (KTI 2016, p. 5)

2.4.11 Real estate taxes

Real estate tax is based on the taxable value or the building and the plot and it is calculated by the specific tax rate that the municipality has. (KTI 2016, p. 5)

2.4.12 Other maintenance costs

This item of expenditure consists of costs that cannot be allocated to other sections. The target is that no costs are recorded into this section. (KTI 2016, p. 5)

2.4.13 Repairs

Repair costs consist of costs that come from keeping the machinery and structures in their original condition. These actions are usually periodic, recurrent and predictable. Usually they are based on long term plans. In addition, all the unpredictable repairs (such as water damages) are recorded here. (KTI 2016, p. 5)

3 Facility management software

This chapter presents what facility management does and why do they exist: what are the functions they are in use and what factors do they provide. Usually these software are done by service as a software, which is also presented in chapter. Lastly, the overall savings that they cause are presented to view the advantages of these software.

3.1 Service as a Software (SaaS)

Service as a Software is a method of providing and distributing the functionality of a certain software that permits an individual or an organization to use and to benefit from its usage without the need to implement or ongoing management. SaaS eliminates the need for in-house staff to maintain and upgrade the software, as the software is hosted and upgraded by the service provider. (Poór 2014, p. 2)

SaaS basically is an umbrella term and it can mean basically anything related to internet services, due to the broad overload of the term service. Basically, SaaS separates the possession and ownership of the software from its use. The concept enables a demand-led approach on software development and marketing and can provide services that need to address a particular problem or requirement. Delivering such a software that is distributed as sets which can be configured at delivery time can usually overcome limitations to regular software, such as use, deployment and evolution. They also make possible to create and develop new features and services that use the existing ones. (Turner, Budgen & Brereton 2003, p. 38)

This means that the SaaS approach lets the set of services provided evolve without any intervention to the business and its context change. It is not necessary who provides the service but what service transactions require at any point of the process. Although programming languages have been out for decades, the basic paradigm for constructing software has not changed over the years and it follows the basic edit-compile-link-cycle. To achieve a SaaS approach, other models are largely used, because of service-aspect of SaaS: the software should a specific set of requirements, somewhat of a vision of an instant service. The software is usually either supply- or demand-led. Figure 6 shows how these models differ from each other:

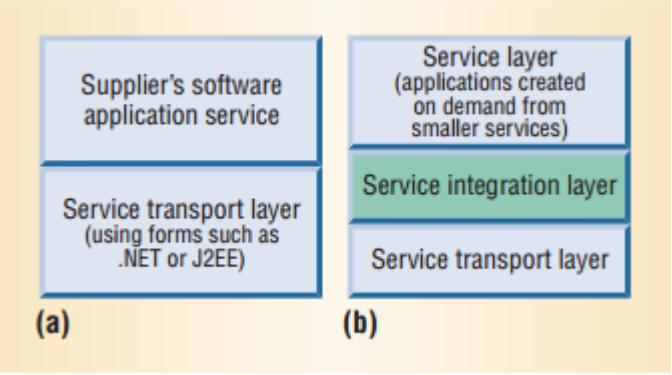

Figure 6: SaaS service models (Turner, Budgen & Brereton 2008, p. 39)

In figure 6 model a) shows an interpretation of a service model that is supply-led: a set of applications are transported through a transport layer to the customer. Model b) shows how the demand-led SaaS works: applications are only created on demand and they are integrated specifically to the customer via the integration layer. The most radical change is the service integration layer, which employs software technology to support the different concepts that are related to business and supply models that the service needs. The integration layer incorporates four service-oriented functions that are essential to it: service description, service discovery, service delivery and service composition. (Turner, Budgen & Brereton 2008, p. 40)

Service description is a function that matches client's needs to available services that suit best to their requirements. Basically, it maps the means from provider's offerings to client's needs. The description should answer to functionality, interfaces, characteristics in addition with quality and cost of the service. (Turner, Budgen & Brereton 2008, p. 40)

Service discovery is used by clients to locate appropriate services that match their requirements and criteria of their selection. Thus, client identifies potential service providers whose products are equivalent to their needs and are willing to adapt their products in specific boundaries. It may also consist of other services and it will result in a list of candidate services and their providers. *Service negotiation* generates the interaction between the client and one or more service providers, that are identified through the discovery process. It aims to generate an agreement on the terms and conditions for supplying the service. (Turner, Budgen & Brereton 2008, p. 40)

Service delivery is a three-step process. In invocation process the client calls for the provider to supply the specified service by the terms they agreed in the deal. In order to validate the invocation, the service provider must supply the agreed service within the time period provided in the contract. When the bounds are met, the suspension step establish the point where the client no longer needs the provider to supply the service ((Turner, Budgen & Brereton 2008, p. 40).

Service composition means the know-how in which the service provider can compose its service from another service that isn't so developed. Such knowledge is only sufficient when the service is constructed from services where rules already exist. The idea is to create new forms of service on demand from pieces that already exist. (Turner, Budgen & Brereton 2008, p. 40)

SaaS model requires that when discovering a suitable, the client and the provider must negotiate the delivery terms automatically. Some parameters allow this to happen, but none allow them to be fully automatic. The demand-led model also needs the contracts to be electronic in order to seal the deal. (Turner, Budgen & Brereton 2008, p. 44)

3.2 Facility management software

Facility management software have traditionally provided the maintenance book for a certain building, including the maintenance plan and all the documents regarding the building. The first facility management software took place in the 1980's and then they were installed into one's computer. Facility management software are also called computer aided facility management (CAFM). CAFM's differ from facility management software, because they are

systems that support facility management processes and they are based on graphic representation of the area with informational support. CAFM is based on the close integration between utility issues between building and its workers and tenants and provides accurate models about its equipment. CAFM is not about the equipment, but about the descriptive information that the CAD models provide. CAFMs provide space management, lease management, equipment management and the information of movable property, whereas facility management software provide something else. Combining these two is the future what and where the whole business is going in the future. (Poór 2014, p. 2)

Nowadays facility management software's provide much more to the customer. They also include maintenance plans and maintenance audits, service requests, energy metering, long term plans and contracts. All the capital expenditures are included in the long-term plan, so customers can also add billing into long term projects as well. (Granlund 2017).

The amount of information in facility management software has grown rapidly, and the newest additions now and in the future, is adding building information model (BIM) and CAD (computer aided design) data into facility management software. This provides new opportunities to facility management software: the condition assessments integrated to ease the planning of deferred maintenance and to ease the valuing of a certain property. Another addition is database management systems, which add the more value to long-term budgeting when these databases are added to facility management software. The aim is to reduce the deferred maintenance backlog, which has emerged into a serious issue worldwide and institutions have started to reduce the amount of repair debt. With the addition of long-term planning the amount of deferred maintenance backlogs will not emerge in the future. (Teicholz 1995) The main function is to help facility managers to reduce operational costs. (Kriksciuniene et al 2014, p. 12)

The maintenance support relies on maintenance requests. Usually these requests are done by the occupiers of the building and resolved by the maintenance staff, who also make these requests. Then the request passes different phases, such as assigning, scheduling and completion. All these phases aren't registered in the software itself, usually the phases are requested, taken into process and completed. In the completion phase the maintenance staff usually registers what they have done and ensure the completion of the request. The main problem lies in the insufficiency of these requests. Either there is lack of data or the system is polluted with trivial problems and false alarms. But, because the request making is in the hand of the occupier, it is hard to trim these problems. (Kriksciuniene et al 2014, p. 12) Still, the maintenance support and requesting has been the foundation of facility management software.

Another tricky part is energy metering. Because they are often metered, for example energy consumption, the software also utilizes the data also, usually straight from energy vendors. Still, the facility managers usually want much more diversified data, which complicates the metering for individual tenants. Thankfully the metering and IoT has eased this process, but still, in old buildings, the metering systems might be outdated which results in non-efficient use of facility management software. (Kriksciuniene et al 2014, p. 13) Still, building automation is integrated in most facility management software, which enables more accurate

monitoring in addition with remote metering of electricity, water and heat (Lewis, Riley & Elmualim 2010, p. 8)

The newest addition to facility management software is IWMS, integrated workplace management system, which is an upgrade to CAFM because of its boarder range of functions. IWMS consists of several functions:

- Capital project management: this function involves different activities that are associated with development of new facilities and remodeling existing facilities. It also includes reconfiguration and expansion of facilities. It includes capital planning, design, funding and bidding, cost management, documentation in addition with scheduling and critical path analysis functions.

- Portfolio and lease administration: This area addresses strategic planning (site identifications, selection and development), capital planning, RFP and lease analysis, portfolio management, lease- and transaction administration, all which support key functions of company's core processes.

- Space and facilities management: This area is broad, but basically it covers all actions regarding the operation and optimization of facilities. The functions vary from facility planning, space management, resource scheduling, security administration, health and safety matters in addition with analytics tools to facility and space management.

- Maintenance management: This area includes parts from CMMS (computerized maintenance management systems and it covers preventative/unplanned/reactive maintenance management, warranty management, inventory management in addition with work order administration.

- Sustainability optimization: This area is the most rapidly growing and its main focus is to optimize energy consumption. It addresses energy efficiency management and reporting, waste management and recycling, calculating carbon credits, pollution absorption in addition with certification for LEED and BREAAM.

4 Summary of the theory

Facility and property management is a wide concept, where different aspects support each other and no aspect can be separated from another. Maintenance itself can be done in various ways, preventively or correctively but hopefully it is done optimistically to reduce the errors that preventive maintenance does. To achieve better results in maintenance it is crucial to adapt correct tools to it, and here facility management software take place. To categorize and make maintenance even more systematic, facility management software ease especially the scheduling of different maintenance actions that occur in the building. In addition to controlled maintenance, the overall capital expenditures can be controlled to strengthen the overall cost control. In addition to cost control they help to operate the economic life cycle of the building and ease the workload of facility managers to control and care their assets in the specific strategy that the owner wants.
In addition to controlling the capital expenditures and maintenance, facility management software provides excellent tools to meter heating and cooling, electricity and water consumption of the real estate. It is about the metering tools how well the metering is done, but it is possible to provide almost real time data about the different consumption classes of the buildings, which provides strategically important information to facility managers, which can be used to reduce consumption and therefore consumption, when the metering is accurate and can be scoped specifically to wanted parts of the building.

Because of these different features, facility management software helps buildings achieve and preserve sustainable features to the building. They cannot help with construction costs and such, but with active monitoring and long term planning they help to achieve even more sustainable values and therefore increasing their market value, at least in increasing the image of the building. Energy and waste reduction for instance are one divisions that BREAAM and LEED categorize when valuating different buildings with pollution and water consumption, and FM software are great tools to reduce those with active monitoring and systemizing the usage of the building and its occupiers.

But as FM software usually are done via SaaS model, they can also be altered by the terms and strategy that the customer wants and this is crucial when choosing the software. Although in SaaS model software can be altered from different kind of services, this is not usually the case in FM software, they are usually done by specific providers because the field is quite unique and laws control the field strictly, which makes the field uniform.

All and all, without skilled facility managers, maintenance personnel and purpose built software, facility management software will not help, if their users are not skilled to use these software and do not use them adequately. Active collaboration and communication between service providers and customers is needed to achieve results and get the full advantage that these software provide. Although these software might seem a bit bulky, they are usually widely customizable to match the preferences that their users need. Skilled facility managers need skills and specialization in operations and maintenance, human and environmental factors, planning and project management, finance and in technology, which are all features that FM software can improve.

5 Maintenance cost comparison

In this chapter, the overall financial situations and idiosyncrasies of different markets are explained, in addition to the overall qualities of these markets. In the end of the chapter the overall maintenance costs are compared to get a comparison about different markets and how facility management software can achieve savings into these different sectors.

Maintenance costs, or occupancy costs are gathered from different service providers. In addition, a few real estate evaluators were interviewed about their calculations. Because the date seemed to be insufficient, it was needed to gather their estimates of the capital expenditures and operating expenditures and maintenance costs they use in their calculations to gather more accurate sample of data.

All the maintenance costs are calculated from the analysis made by CBRE, so the values are relatable and because no other factor provides occupancy cost data from all the different areas that this thesis researches. The original data was normalized to euros and all the rent costs were reduced from them, to minimize the differences that different rent levels cause.

5.1 Scandinavia

This chapter presents the key figures and overall trends in the Scandinavian markets, mainly focusing on Finland altogether. The 2016 ended up as a record year in the Nordic transaction market, with the total investment volume on 40,5 billion euros, which was increased by 4 % to the previous. The investment volumes in office and retail went down, but on the other hand industrial and residential markets went up, which can be considered as a success. Figure 7 shows the investment volume of Europe and Nordics from 2011 to 2016 (CBRE, 2016).
The latest years have gone in a bit of a turmoil in the Nordic markets (for instance in Finland the year 2014 ended with 0% growth in GDP, inflation was just 0,5 %) because of the reduction of global oil prices. Inflation was -0,2 % in the end of the year 2014. But the future looks altogether bright because of the strong interest of the international investors over the Nordic markets. (CBRE 2016, p.2) (CBRE 2015, p.3)

The property taxes in Sweden varied from 0,5 % to 1,0 %, in Denmark from 1,6 % to 3,4 %, in Norway from 0% to 0,7% and in Finland from 0,8 % to 1,55 %.

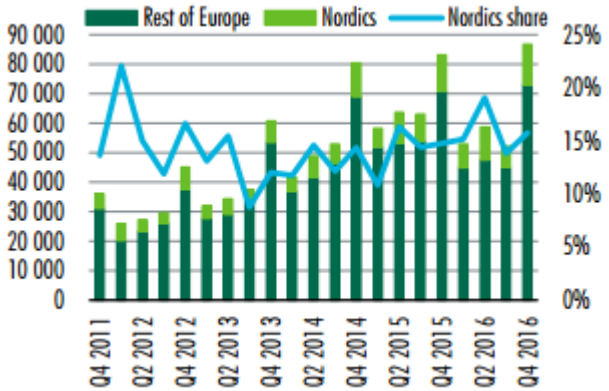

Figure 7: Investment volume Europe and Nordics 2011-2016, (€ mn) (CBRE, 2016)

5.1.1 Main figures from Scandinavia

These main figures show the basic financial indicators of the countries, as well as the key figures of real estate investments. The basic financial indicators are gathered from The World Bank and The Economist, whereas the real estate figures are made by CBRE.

	Population	GDP	GPD, % change on a year ago				Industrial production, % change on a year ago	Consumer prices % change on a year ago			Unemployment rate
	Millions	billion $	latest	quarter	2016	2017	Latest	Latest	Year ago	2016	Latest
Finland	5.482	231.95	1.6	1.6	1.4	1.1	3.7	1	-0,2	0.4	7.9
Sweden	9.798	495.624	2.8	2	3.1	2.4	0.1	1.7	0.1	1	6.5
Denmark	5.676	295.091	1.1	1.5	1	1.4	13.3	0.5	0.4	0.6	4.3
Norway	5.195	386.578	-0.9	-1.9	0.6	1.1	2.6	3.5	2.3	3.5	4.7

Table 2: Key economic figures in Scandinavia (The Economist, 2017); (World Bank, 2017)

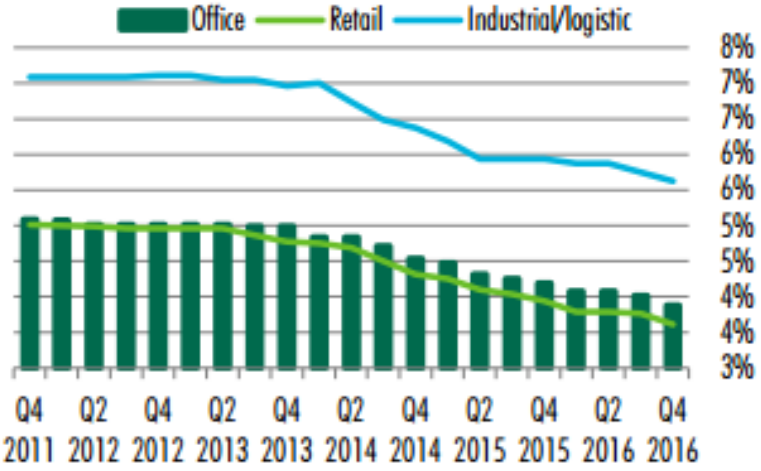

Figure 8: Nordic Prime Yields 2011-2016 (CBRE, 2017)

Prime Yields	Office	Q3- 16	Retail – High Street	Q3 - 16	Industrial/ Logistics	Q3- 16
Denmark	4.00	↓	3.20	↓	5.75	↓
Finland	4.00	↓	3.75	↓	5.75	→
Norway	3,75	↓	3.75	↓	5.50	→
Sweden	3.75	→	3.75	→	5.50	↓
Nordics, average	**3.90**	↓	**3.60**	↓	**5.60**	↓

Prime Rents (Local currency)	Office	Q3 - 16	Retail - High Street	Q3 - 16	Industrial/ Logistics	Q3 - 16
Denmark (DKK)	1,800	↑	20,000	→	550	→
Finland (Euro)	456	↑	1,940	↑	137	↓
Norway (NOK)	4,200	→	25,000	→	1,200	→
Sweden (SEK)	6,100	↑	20,000	→	925	→

Table 3: Prime yields and rents in Scandinavia, 2016 (CBRE, 2017).

As shown above, the yields have gradually lowered from the year 2013, which means that the overall trust towards the real estate markets have grown. In addition, the transaction volume has grown since that because of the growing interest of international investors. Still, the domestic investors continue to dominate these markets, but the international interest has grown steadily due to the good performance of these markets.

5.1.2 Maintenance costs

In Helsinki Metropolitan Area, the average maintenance costs were 3,97 € / sqm / month in 2015. Rents were not included in this figure due to the impossibility to compare to other figures (KTI 2016). CBRE on the other hand calculates that the occupancy costs were 9,2 € / square meter / month, which means 110 € / sqm / annum. More detailed figures can be found on appendix 2.

In 2016 CBRE estimated that the overall occupancy costs in Stockholm's prime office space were 9,9 € / square meter / month, which is 120 € / sqm / annum. Oslo was monitored to have occupancy cost of 7,3 € / square meter / month, which is 87 € / sqm / annum. Copenhagen's occupancy costs were 9,3 € / square meter / month, which is 112 € / sqm / annum. You can see the results in appendix 1.

5.2 Spain

Although the overall outlook on economy globally seems a little bit weak, Spain performs very well, with the highest forecast in Eurozone, between 2,7 and 2,8 %. The high activity

in investment markets from recent years will be toned down a bit, but it shall still be a busy year with the forecasted investments of 8,5 – 9,5 billion euros. The biggest challenge in the markets will be the lack of supply, especially in Barcelona and Madrid. The hotel sector is also booming and the visitor numbers are breaking records every year. (CBRE 2016B, p. 4)

Spain has become one of top investment markets in Europe real estate-wise, when it bounced back in 2014 (see figure 9 below) after hard years of recession. The investment volume was risen 25% to 13 billion euros. Especially the office sector was widely invested, accounting for 43% of all investments in 2015. All the marks show that this will also continue in the future. In addition, the REITs (or Socimis in Spain) where highly active and number of different REITs grew to 13 at the end of February 2016. There have also been great changes in the market, the market has evolved from an opportunistic market to core market when institutional, insurance and private rental investors entered the market in 2013. As said, the greatest challenge is the lack of product, which is caused by the rapid increase in demand. (CBRE 2016B, p. 10).

At the office market the vacancy rate has dropped because companies have started to gain more space which they cut during the years of financial crisis. The prime rents are still below than those achieved ten years before, and nowadays companies are ensuring they get the best available premises. Madrid and Barcelona are the main areas that are being vacated. It is also expected that the available supply will continue to fall due to lack of supply and increase of take-up levels. Therefore, the rents continue to increase in the major cities and sub-markets, due to active demand and the lack of danger of oversupply. (CBRE 2016, p. 12-13)

Retail premises were also recorded positive when private spending grew 3,6% and unemployment rate fell 2 percentage points in 2015. The retail sector recorded 3 % turnover growth in that year which resulted in increasing growth of retail unit demand, both domestic and overseas companies, most of them high-street retailers. These caused that the prime rents rose 10 % in 2015. The activity in shopping center development eased this demand but it's effects fully activate in the future. (CBRE 2016B, p. 16-17).

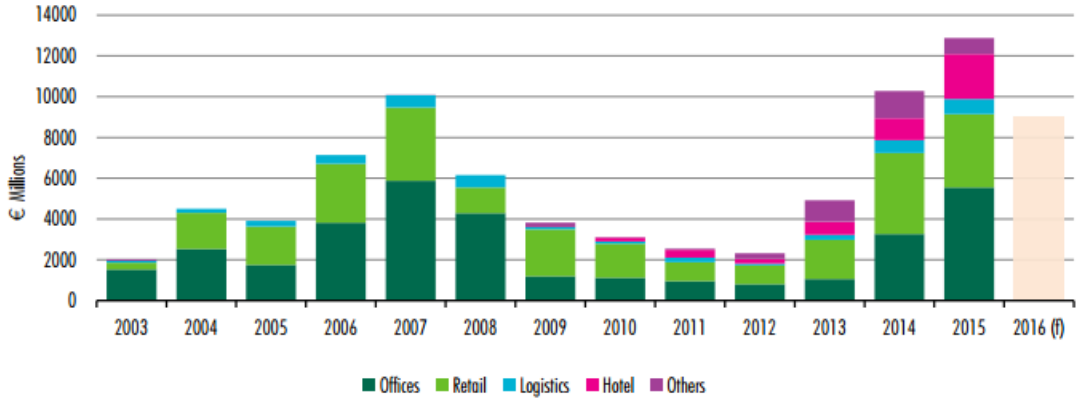

Figure 9: Change in Prime Yields 2006-2016 in Spain (CBRE 2016B, p. 10)

5.2.1 Main figures from Spain

These main figures show the basic financial indicators of the countries, as well as the key figures of real estate investments. The basic financial indicators are gathered from The World Bank and The Economist, whereas the real estate figures are made by CBRE.

	Population	GDP	GPD, % change on a year ago				Industrial production, % change on a year ago	Consumer prices % change on a year ago			Unemployment rate
	Millions	billion $	latest	quarter	2016	2017	Latest	Latest	Year ago	2016	Latest
Spain	46.418	1199	3	2.8	3.2	2.3	4.6	1.6	0	0.3	18.4

Table 4: Key economic figures in Spain (The Economist, 2017); (World Bank, 2017)

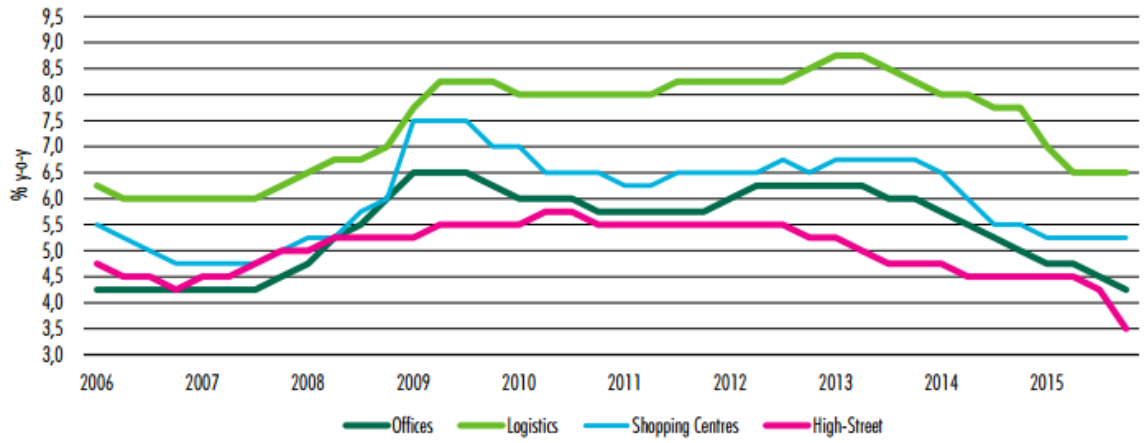

Figure 10: Change in Spain's prime yields in 2006-2015 (CBRE 2016B, p. 10)

As shown above, the overall yields have lowered from their high point in 2013 and returned close to 2006 figures, which indicates that the trust in Spain's market has grown after the recession. The active demand for Spain's real estate and the stabilized financial sector have made possible to lower the overall yields when the country's overall situation has stabilized.

5.2.2 Maintenance costs

Spain's maintenance costs were from CBRE's report and they measured that in 2016 Barcelona's prime office rents were 7,0 € / square meter / month and early 84 € / square meter / annum. This is significantly lower than in Scandinavia.

5.3 China

The overall Asia Pacific market has grown rapidly in the last decade, with a 5,4 % growth in investments. In addition, the annual rent growth has stabilized when it earlier was 5-6% yearly. The main drivers for the growing market are solid employment, wage gains and technology sector's growth. Therefore, a strong occupier demand can be seen, which is coped with strong office completions. The office market drew an all-time high in investments whereas the retail and hotel markets also grew steadily in 2016. Macro-economic themes will influence the investment activity: the strengthening U.S dollar and China's economic rebalancing towards it will play a strong role. It can be expected that the yields continue to fall due to the overall inflation prospects that remain low and the favorable market momentum. (Cushman & Wakefield, 2016, p. 11-12)

The overall construction boom in China has been prolonged and left China in debt and excess capacity in some industries but there's still evidence that the fiscal and monetary stimulus are helping to balance the gross domestic product growth and therefore support the demand.

Shanghai's office completions will peak in 2016, totaling for over 26 million square feet across the commercial business district (CBD). About 60 % of the new supply will be located in the emerging submarkets, which might occur in tenant competition and soften the rental growth. The core CBD markets, such as Lujiazui and Jing'an will remain under strong occupier demand, keeping the rental levels high. These occupiers well remain active especially in the technology field. Also, foreign investors have become more optimistic in Shanghai's property market, especially the decentralized markets.

5.3.1 Main figures from China

These main figures show the basic financial indicators of the countries, as well as the key figures of real estate investments. The basic financial indicators are gathered from The World Bank and The Economist, whereas the real estate figures are provided by Cushman and Wakefield.

	Population	GDP	GPD, % change on a year ago				Industrial production, % change on a year ago	Consumer prices % change on a year ago			Unemployment rate
	Millions	billion $	latest	quarter	2016	2017	Latest	Latest	Year ago	2016	Latest
China	1371	11008	6.8	7	6.7	6.4	6	2.1	1.6	2	4

Table 5: Key economic figures in China (The Economist, 2017; (World Bank, 2017)

	Vacancy Rate (%)		Supply 2016-17	YOY Rent Growth
	2016	2017	('000 Sf)	2015-16
Adelaide	13.3%	12.4%	115	STABLE
Beijing	9.0%	12.0%	30,330	DECREASING
Brisbane	19.0%	17.0%	2,045	DECREASING
Hong Kong	6.50%	7.80%	4,679	STABLE
Melbourne	7.4%	6.0%	773	INCREASING
Perth	21.3%	19.0%	54	DECREASING
Seoul	12.1%	12.3%	1,667	DECREASING
Shanghai	16.0%	15.0%	36,603	STABLE
Singapore	13.9%	13.3%	4,169	DECREASING
Sydney	6.7%	5.8%	3,339	INCREASING
Taipei	12.5%	14.0%	2,569	STABLE
Tokyo	5.0%	4.8%	8,211	INCREASING

Table 6: Asia Pacific-areas vacancy rates and real estate supplies 2016-2017 (Cushman and Wake-field 2016, p. 14)

5.3.2 Maintenance costs

These maintenance costs only cover for Shanghai's market, the grade A properties in the CBD region and when relevant, the new prime centers that are well located. CBRE evaluated in the year 2016 that in Shanghai (Pudong area) the occupancy costs were 132,78 USD per square feet per annum, which is 1429,23 USD per square meter per annum.

5.4 Middle East

This sub-chapter focuses entirely on United Arabic Emirates (UAE), especially to Dubai. After 2008, the housing prices in Dubai have been adjusted radically after the prices peaked that year. The decline after 2008 was caused by several factors: global uncertainty, circumstances globally, regional uncertainty and the oil price. The circumstances in China, Russia and Iran and their macroeconomic environments impacted the global financial markets. Their currencies declined against USD which impacted the overall purchasing power. The non-oil sector drives the country's economic growth despite the descending oil prices (CBRE 2016, p. 2). Also, the UAE currency peg against US dollar caused global investor to evade the UAE's real estate market. Because of the diversification of UAE's economy, oil prices have huge an effect towards the market. When the oil prices decline, the government cuts budgets which means that the infrastructure growth also declines. UAE has made regulatory changes to stop the declination of their markets situation. The main actions were property transfer fees, rental regulations, escrow account enforcements and mortgage caps. (KPMG 2016)

The office supply Dubai has risen from 7,6 million square meters (2014) to 8,6 million in 2016 and it is estimated to rise to 8,9 million in 2018, so the growth is slowly stabilized. In the meantime, the vacancy rates have also gradually reduced from 22 % to 15 %. Rents have remained the same, with a marginal 2 % increase yearly. The increase in rents can be seen stabilized in the future. (JLL, 2016, p. 3) Retail supply has also increased from 2,9 million square meters to 3,4 million from 2013 to 2016 and is expected to grow to 3,7 million in 2018, all because of two retail centers. Vacancy rates and rents have been gradually the same, 8 % for the first and 0 % for the latter. (JLL 2016, p. 5)

5.4.1 Main figures from Middle East

	Population	GDP	GPD, % change on a year ago				Industrial production, % change on a year ago	Consumer prices % change on a year ago			Unemployment rate
	Millions	billion $	2015	2014	2013	2012	Latest	Latest	Year ago	2016	Latest
UAE	9.156	370.296	3.758	-5.243	4.855	10.853	4.5	0.695	1.67	2.54%	2.58

Table 7: Key Economical figures in United Arab Emirates (The Economist 2017) (Tradingeconomics 2017); (World Bank 2017)

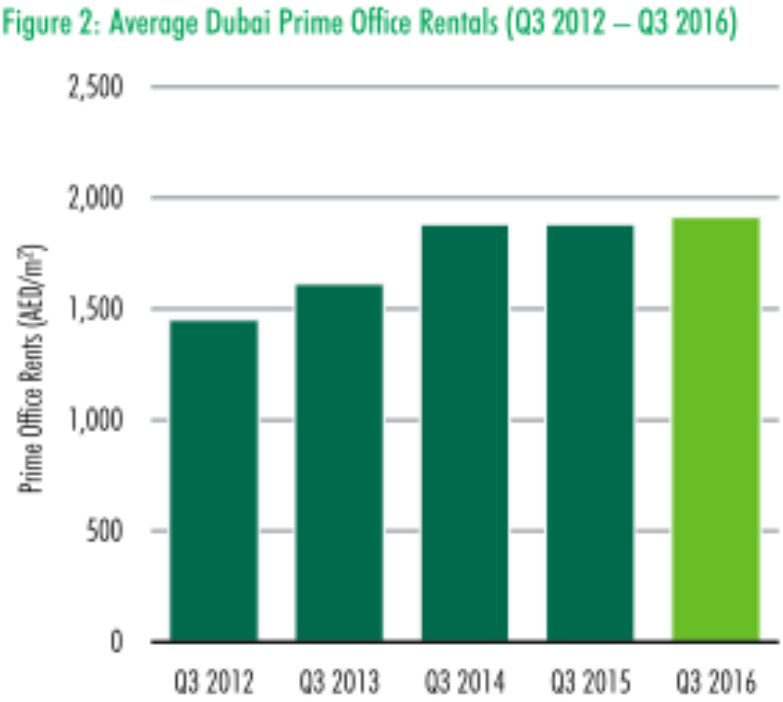

Figure 11: Annual Dubai prime office rentals 2012-2016 (CBRE 2016, p. 3)

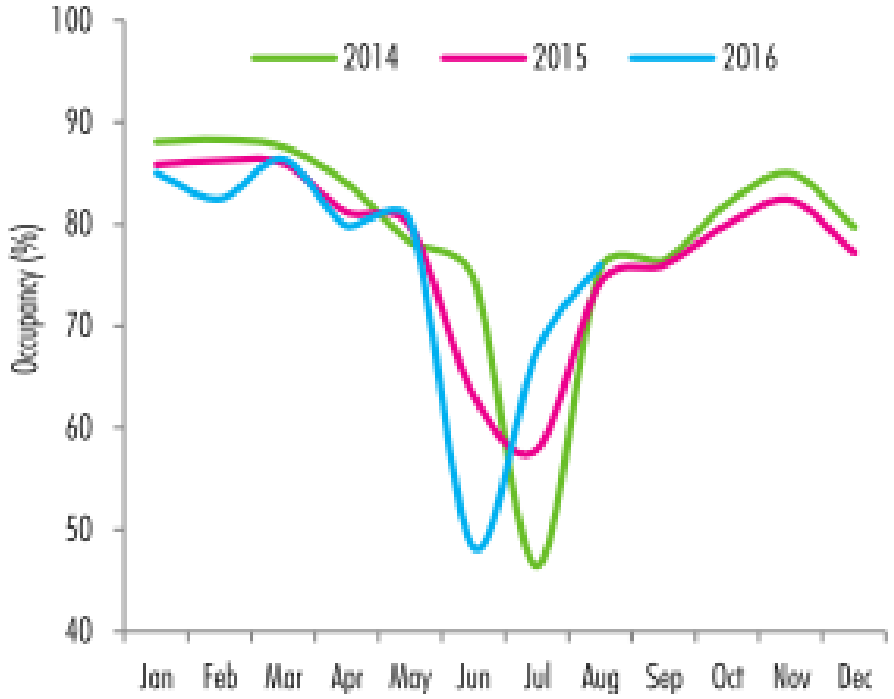

Figure 12: Dubai occupancy rates 2014-2016 (CBRE 2017, p.3)

5.4.2 Maintenance costs

In the year 2016, CBRE measured that the prime office occupational cost is 35 € / square meter / month in the Pudong area in Shanghai, whereas in Puxi region they were 30 € / square meter / month. CBRE has monitored that the occupational costs in Shanghai are one of the highest in the whole world, ranking in top ten overall.

5.4.3 Findings

As seen above, the overall maintenance cost data is extremely hard to find. There aren't many service providers, who give out such information, and if do, it is extremely narrow: it only consists of maintenance costs in prime locations, but any further locations are not provided. This value is also given as occupancy costs, which is not the same than maintenance cost. In addition, the data provided is not accounted for, excluding KTI. Only a certain number is given, but it is not accounted for from what parts it is consisted and in which portions they are divided. This means that the occupancy cost data could not be compared reasonably. You can't be sure whether real estate taxes are counted in the occupancy costs and because they vary so much between different regions, any optimizations and alterations are basically impossible due to data inaccuracy.

There are different factors that generate differences between different regions. For example, heating costs are greater in Scandinavia due to harsher climate. Instead in Shanghai the administration and the usage and maintenance costs tend to be higher due to the enormous amount of workforce that take care of the buildings, therefore the salary costs rise rapidly. The great demand for land and suitable real estates for suitable premises raise the land tax, which due to the extremely high demand effects the prices in China for example considerably, especially in the prime office areas because there, suitable land is a scarce resource.

In general, it can be said that the different kind of markets and conditions make the greatest differences between occupancy costs in general. Maintenance can be also done differently, as we have earlier learned, and the different habits for doing it also make differences between these costs. Due to varying procedures, CMMS software usage, buildings, climate, region and ways of working, it is impossible that these values could be the same.

6 Interview survey

This chapter presents how the interview survey was made. The chapter presents the structure of the survey, choosing the target group, the interview questions and how the survey was done and how the results were analysed.

6.1 Interview survey as a research method

This thesis was done partially as an interview survey. It was done by interviewing for about an hour representatives of chosen companies, where their views and opinions were reached out. These interviews were done as half-structured, or as so called theme interviews. It is typical that the interviewees know the themes that the interview consist of, but the interview itself does not follow strict questions, but more freely, focusing on wanted themes (Hirsjärvi et al 2006, p. 203). Still, typically in theme interviews all the questions are done through, but their order might vary (Aaltola & Valli 2001, p. 26).

The purpose of the theme interview was to gather an overall picture of the added value that facility management software creates to companies, how much do they save costs (both maintenance and energy) and what do they consider as the biggest advantages that they create. With inductive inference conclusions and generalizations were tried to make about the researched subjects and to point out significant observations. In addition, the survey findings were compared to the theoretical background

6.1.1 Choosing of the target group

The target group was chosen by the interests of Granlund's business objectives, in addition with the company's profile. The main criteria were, that the company uses any kind of facility management software and the interviewee had used it, in addition with that he had knowledge about the savings that they have caused with overall knowledge of the companys financial situation and how the facility management software is used. Other criteria were that the interviewees came from the regions that the thesis already has covered, to get more reliable answers regarding these regions from professionals who operate in that field.

In the target group interviewees were chosen from companies that use any kind of facility management software and operate in real estate sector, also managing properties. The target was to interview one personnel from each region, in addition with couple professionals inside Granlund. The correct amount of theme interviews is reached when new interviews do not bring anything new to the researched subject (Henttonen 2008). The overall number of interviews were kept quite small, because the main focus was to provide more information to the quantitative analysis and to support the suppositions it provides.

6.1.2 Interview questions

Questions guiding the interview are presented in annex 1. In every interview, not all questions were asked verbatim, but the conversations in interviews were linked to questions and their themes. In the interviews themes were gone through and same questions were asked, if answers to them were not had in the earlier conversations. The order of the questions varied between interviews and was dependent of the course of the conversation.

6.1.3 Implementation of the interviews

After the suitable interviewees were chosen, I contacted them via email or telephone with a cover letter, telling about thesis and the interview and adding the questions as an annex to the mail. Also, a brief summary about the master's thesis project was added and asked about company's interest to take part in the survey.

The interviews took an hour. During the interviews the interviewer made notes and worked as a recorder. The notes were then gone through and they were supplemented after the interview if needed. The interviews weren't recorded to keep the interview situations relaxed.

6.1.4 Analyzing the interview material

After the interviews were done the notes were analyzed and written out right after the interviews, so the conversations were in fresh memory and they were easier to be written out, not just to be based on what might have been discussed. After the discussions, the conversations were written out into summaries that were sorted into different themes that were discussed.
If there were other things that were discussed, they came out because the interviewees seemed to think that they were important to the whole business.

When all the interviews were completed, it was possible to gather more accurate analysis of the subject. The companies were not divided into different sections, but the answers were divided for how they used different parts of CMMS, what kind of advantages they valued most. Further analysis was done to seek for the differences that different fields have in previous mentioned subjects.

6.2 Target companies in the survey

Because of the criteria was strict for interviewees (companies should use facility management software and they would have to manage their own real estate and would have to know how they affect to their business, what kind of savings they cause and how much), no classification was made in which field the company operates. Next the companies that were interviewed are presented.

Suomen yliopistokiinteistöt Oy – University Properties of Finland Ltd

University properties of Finland Ltd is a real estate owner that is two-thirds owned by universities outside the Greater Helsinki region and one-third owned by the Finnish government. They produce and lease premises to their customers and they solely operate in the university field. The company's real estate capital is 1,1 billion euros and it has grown steadily from its founding in 2010.

Citycon Ltd

Citycon is Finland-based real estate owner, that is focused on shopping centres. It has total assets worth of 4,9 billion euros and it has focused solely on shopping centres in Scandinavia in addition with three in Estonia and one in Lithuania. It has enlisted in stock exchange.

City of Vantaa

Vantaa is the third largest municipality in Finland and a border neighbor to Helsinki, locating in the southern Finland. Vantaa's real estate department is responsible for developing the city's real estate portfolio and its services, obtaining land areas, with main points in being sustainable, energy efficient and cost effective. Real estate department has different sectors: project preparation department, which plans and organizes clearance for premise networks in addition with controlling all the documentary of their ownings.
Construction sector is for example responsible for planning and constructing and all factors regarding to it. Space management – sector controls customer relations, renting and plans real estate maintenance and these three sectors form the foundation of Vantaa's real estate department.
Vantaa owns 850 premises if apartments aren't taken into account, with incoming revenue of 140 million euros. Because Vantaa is relatively young city, it's building stock is mainly from 1980's or younger. Almost 80 % of its buildings are either educational or hospital buildings, if measured by gross area.

Senate properties

Senate properties is a Finnish, unincorporated state-owned enterprise which manages a major part of real estate owned by the Finnish Government. They manage the usage of the governments buildings, in addition with their sale and development. Senate properties controls 9300 buildings, which have and area of 6,2 million sqm. Their property portfolio is valued for 4,4 billion euros and their yearly turnover was 599 million euros in 2016. Senate properties all actions are based on responsibility, both social and environmental. They promote new ways of working, efficient space usage and cost efficiency. The interviewee, Esa Halmetoja, works as a digitalization specialist, and his job description covers IoT, smart buildings and building information models and their usage in facility management.

DNA

Dna is a Finland based, listed stock exchange corporation, that is founded in year 2000. It is a telecommunications company, that in Finland operates mainly as a tele operator. It is one of the three companies, that own its telecommunication and mobile networks. In year 2016 its revenue was 858,9 million euros with earnings of + 65,2 million euros. The interviewee, Petri Penttilä, works as a device design professional, and for the past 2,5 years he has been thai main user for computerized maintenance management software.
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7 Results

This chapter presents the results from the interview survey and how they are linked up to the data analysis done from gathered real estate maintenance data. Results are divided by different themes that were questioned in the interview survey. In the last part of the chapter, different challenges and needs in CMMS and real estate field are presented.

7.1 Facility management software usage

In general, the interviewed companies used maintenance book, all actions linked to maintenance, such as service requests, document archive, long term planning, energy metering and auditing. In addition, companies have other software linked to CMMS, such as finance management or waste management applications, which are usually provided by the factions that the companies have subcontracted them. Companies used LTP linked to billing applications to see the budgeted and realised costs that the repairs have caused. Also, energy monitoring was usually done partially in collaboration with other software to provide more accurate monitoring and reporting. Basically, all the technical maintenance procedures were run through a facility management software, were the most important parts were long term planning, maintenance audits and documents: most pointed out that it is very important to have all the documentary in same place and it can be obtained by all users, so that the management can also keep track of the process and the reports aren't just left in the hands of maintenance workers.

Citycon also used auditing tools to support evaluation of their contracts, support competitive bidding and of course to evaluate their overall maintenance standards. They also pointed out that the ability to gather documentary from different applications is important to gather data so that the threshold to use different applications would be minimized and the advantages from them would be maximised.

Interviewees also pointed out that when earlier the facility management software was just a tool for maintenance and property managers it now is also a tool for directors: it is a data provider which gives out data for shareholders in terms of forecasts but also to provide essential data to members of the board. It provides data that can be split up into smaller portions and thus allows to focus on a much more delicate level to the whole real estate portfolio in a grass root level. It also allows offices in different countries to focus on their own systems, because the data provided is above them, which allows different sectors to operate more leanly.

Senaatti had a bit different approach to CMMS, because they were the only who had an in-house software accompanied to their process, which was done firstly in collaboration with VTT technical research centre of Finland. When VTT ended their project, Senate started to develop it on their own. For about 10 years ago, they analysed their FM software status, and decided to go with one service provider, and combined their five software to one with deep collaboration with the service provider. In addition, with the main CMMS, they use software

that their other service providers provide, such as elevator FM software or energy metering from electricity providers.

City of Vantaa differed from other interviewees by their FM process. Their renewal process is still ongoing, but they use one portal to control all their functions. Vantaa uses Rapal's Optimaze to control all their different functions, which include facility management (service audits, long term planning, energy metering, invoicing, auditing and maintenance plans), rent control (agreements, invoicing, space control, tenant selection) long term plan investments (integrated to long term plan proposals) and construction investments (if the proposal is over 10.000 euros another software is used). Vantaa also uses auditing to review their apartments after the tenant has moved out, which other interviewees did not do, although they didn't rent out any apartments. They also audited their maintenance company, Vantti, similarly with Citycon. Compared to other's Vantaa also had a link in their intranet to their facility management systems, which allows larger collaboration for making the service audits, which enhances the handling pace of these requests.

DNA was different from other companies, because they use CMMS for upkeeping their equipment spaces that are used to manage and control telecommunication network they provide. Their office premises are controlled by another CMMS software, but in the interview, we did not discuss about it, because the interviewee did not work in that field. DNA handles technical maintenance, data recording of their equipment and equipment maintenance with CMMS, in addition with energy monitoring and long term planning. LTP and energy monitoring begun in the beginning of 2017 and its advantages can be seen in the future. They do not upkeep all their information, only the most important devices and equipment, more detailed information can be found in equipment's own software. They also have another facility management software that they use in equipment spaces that they rent from other service providers. They have also another facility management software they use to control their replacement part management and their acquisition.

All the interviewees and their companies used maintenance book, service audits, documents, long term planning and auditing processes in their CMMS, with slight variations in both their own procedures and process usage. Most of the listed companies used maintenance book and their maintenance scheduling is customised by their own procedures and then implemented in the CMMS. The used processes are listed in the table 8 below.

	Service audits	Documents	Energy	LTP	Billing	Auditing	Supporting software
Company A	X	X	X	X		X	Billing, construction
Company B	X	X	X	X	X	X	Energy metering
Company C	X	X	X	X	X	X	Electricity
Company D	X	X	X	X		X	Elevator FM, Electricity, project management, indoor climate management
Company E	X	X	X	X			Spare parts management

Table 8: Different functions used in CMMS by service users

7.2 Key function support

Greatest factions that have supported companies are maintenance book, long term planning and energy metering, this came from all the interviewed companies. Greatest reasons to this

were the number of premises they control: such large mass cannot be controlled without tools that are made for that. They also support the maintenance to these buildings, because software is part of it. They also provide the most accurate situation of a certain building and are built to provide essential data about the current situation. Reports were also seen essential, because they allow to lead the real estate mass with accurate information and plan the future. The processes were mainly used as user-centred. The companies provide their own process manuals to the service provider and then they are implemented accordingly, so the general rules are the same to everybody that uses the software. All interviewees also mentioned the possibility of collaboration and involvement with their partners. For example, Vantaa has given out login credentials to all their employees that work for the municipality and each of them can register maintenance audits. It makes the overall process more rapid, when the occupiers of the premises can easily make these audits and they also get to give out their ideas how the system could be improved.

The greatest advantage that companies thought were the data that they get. FM software provides a "window" that gives them information what is happening in their premises and how things in general are, in addition with the in-depth information. Due to this they get opportunities to adjust their performance and ways of working to give better service to their clients and users. Energy metering was other great advantage they received: how to constantly control energy consumption and make actions according to the data they get and how the then change the modes of operation to reduce it. Long term plan was the third big advantage that the interviewees listed they get from FM software. It is critical for them to control all the repairs they proceed and how they are going to proceed with them in the future, how they control their buildings and how much it is going to cost them in the future. Some even used them as a budgeting tool, and University properties in Finland Ltd used it as an invoicing tool as well.

DNA stated that the greatest supporting functions consisted of real-time equipment information and documentation. It allows them to know what kind of equipment they have in their premises, that their blueprints are correct and maintenances are done accordingly to the schedule. Maintenance calendar is linked to this essentially and these functions form the foundation where the rest of the maintenance actions lean on. They eagerly await the results from remote energy metering, which has just started in pilot targets.

Still, many interviewees pointed out that it is difficult to point out the single greatest advantage, because these systems are linked so well together, it is hard to separate one function from another. Still, they thought that maintenance book, long term planning and energy metering formed the core of CMMS and they give out the biggest advantage, but the other functions are also crucial to them, although separately not as important. All interviewees also pointed out that the overall execution speed of different processes has grown rapidly due to new tools: invoicing for example was pointed out, especially from Vantaa.

Vantaa also pointed out rental control: new tools have made it much easier to handle all the rental agreements, rental billing and condition auditing of premises. They provide graphic interface of the premises they hold, which make easier to divide the service areas and control them. In addition, as Vantaa mentioned, they invoice over 1500 rents in a month, which, when automatized, is superiorly agile than previous tools. Facility management services have replaced all the old functions regarding facility management, but implementation of

software that support construction is still done partially by old tools, due to incapability to move to new applications.

7.3 Cost saving opportunities

University properties in Finland could not say how much FM software have saved costs to them, because they have always used them, so they had no reference line on earlier situation. They although said that without the FM software the costs would be considerably higher due to the challenges in controlling the maintenance and long term planning. The software has also made to meet the operations, so that the cost savings would be as high as possible, but the amount of human failure can't be eliminated of course.

DNA could not give any estimate how much costs are saved via FM software, but they achieve biggest cost savings when maintenance is done accordingly by the schedule, so they do not break down, but they do not do anything extra or out of schedule, so the costs stay low. They use this information to make their processes more effective and analyse their cost structure

Citycon could not also say how much facility management software have saved costs for them, because they have used them for so long and shopping centres in different countries use different systems so they are not relatable. Although they said that without these systems all the processes would stop and the amount of time used, for example to long term planning would take excessive amount of time. Different kind of remote monitoring systems (especially regarding to building automation) have saved costs, but they also couldn't say how much. They also said that these applications and software don't itself save costs, but they provide the tools to help in it. None of the interviewees could not tell exact costs due to lack of tracking and the complexity of it.

Vantaa pointed out, that due to streamlined processes, the need to hire new employers, even if the workload grows, does not apply to them, because they have more human resources to allocate to other processes. Thus, they save costs, when the work efficiency increases and they don't have to hire any more employees.

7.4 Energy saving opportunities

Although FM software does not itself save any energy, it provides the tools and reports that allow to measure it and see where the energy goes and where it can be saved. University properties in Finland Ltd measured that with these tools they have saved 5-10 % energy in every field (electricity, heating and water), when they have altered their actions with the data they have received. FM software have provided the data they needed to optimize their energy consumption and to perform the needed tasks to reduce their consumption. They also provide accurate data to reach the problems at least at one hour cycle and then to reduce the costs. The key figure that they give is the basic load that the buildings have and how it changes during the day. Because of real time metering it is possible to spot the faults that the systems have, such as leaking valves or to adapt the habits that the users have and to alter them. Because all the buildings are different, it is also important to get data that is absolute, which allows comparison between different buildings. After achieving the data, it is possible to put the buildings to same line when you proportion them by volume, usage and other factors.

Only then you have the tools to compare different buildings and then make actions to save energy in these buildings when you can review them accordingly.

Senate Properties also said, that it is impossible to say how much facility management software have saved energy costs to them, but they throw an estimate of 15 %, which can be used as an estimate when all processes are centralized to one operator. But, because they always had used facility management software and all their buildings were part of it they could not state exact figures. Still, facility management software support systematic upkeep of their properties and therefore they do provide cost savings to the company. DNA had the same problem, they have not used energy metering for so long that they could not state any facts that how much it has saved them, but they have started measures to decrease their energy consumption from the received data they have acquired.

Interviewees also said that one can't easily track the cost savings that the process swiftness has accomplished in cost savings: because the processes are more agile, there's no need to hire new employees even though the business would be growing. Vantaa also had sort of energy support persons, who spread energy knowledge in their companies, teach about energy consumption and bring out guidelines and guidance how to reduce it. They also pinpointed the importance of metering: it requires monitoring to achieve savings but more importantly, it enables to keep up the wanted level of the overall condition of the buildings. Vantaa has added rewards for lowering energy consumption: their model is called Esco (Energy Saving Company), and they reward their facilities with a certain amount of money, if they achieve to go under a certain consumption level. They do also finance their energy investments with these savings.

7.5 Added value

As mentioned earlier, greatest added value the companies got was from the data they receive and how it helps to control their real estate premises. Because leading is done with data, it is essential to have it in one place and that it is accurate, it can be used in various situations and it is flexible to get different kinds of data. In collaboration with the service providers the owners must adjust the software to match the current state of the buildings and therefore to match the requirements that the users require from it. University properties in Finland also stated that it is also a brand matter: they must have the best available tools and practices to provide the best kind of service and CMMS are crucial in this state to make this possible.

They also provide added value in sustainability point of view because when these systems are used and operations are being intensified it makes the business activities more sustainable. Clients are more and more interested in sustainable development and values have more and more impact in every action, especially in real estate field. And without adequate data it is impossible to develop actions to match demand. It this crucial to have right things in right places and do them with planned timetable. This enhances the life cycle of buildings, lowers the overall costs and circumstances are improved for inhabitants.

Citycon Ltd also pointed out the importance of remote control systems and how they ease maintenance. FM software provide the data bank to gather this information where it is easily accessible and thus allows maintenance companies to head straight there, where the faults

are with minimal timespans. This saves the building and its energy consumption, when for example toilets aren't leaking for long. Tracking of repairs is also vital, because it saves a huge amount of resources when they aren't manually tracked in Excel or other applications. When combined with auditing it allows to focus there, where the problems are with reduces disruptions in the process.

DNA thought that the most important function that gives them added value is the possibility to obtain all the data in the same portal. It also makes possible to achieve real time reports, which allows them to follow all their functions, which is extremely important for a listed company. It also gives them detailed information that processes are taken care accordingly and their contracting parties perform in the way that they have promised. They do not see, that their processes would work without adequate software. They use long term planning as a budgeting tool and see, that it gives them more efficient and more informative budgeting tool in the future, when they can more specifically target their budget to different areas with it.

Vantaa thought that the greatest amount of added value gained was the replacement of old processes, which have made their processes more agile and eased the workload of professionals in their end. Because the city of Vantaa is a public administration, they must work openly, which means that they have to report from their actions accordingly. They thought that it is extremely important to achieve maximum amount of data from CMMS in order to fulfil their obligations defined by the law. It also makes possible to create new applications to reach the need to give out information of the municipality. It also works as an overall view portal to management, because the real estate sector has to report its actions to municipality's officials and leaders. CMMS users (especially property managers) have been very keen to the new software, due to its easiness compared to previous solutions.

Senate properties could not think that they could handle their processes without this software. They also stated, that they do not basically care about the software, they care about the results that it gives. They also stated, that they give out an excellent tool to react to failures, energy consumption is easily metering and therefore it can be interfered. But most importantly, without accurate reports about usage of their buildings it would be impossible to provide any data to support their decision making.

7.6 Mobility

Mobile applications and processes have reduced the duration for when actions happen. It both works as a tool for maintenance and for managers, when the data is gathered into one place. It simplifies and quickens maintenance and eases reporting of done activities, when the CMMS travels with you. They are mainly used when making fault reports, but auditing is also partially done with mobile applications. All the interviewees stated that development should go towards mobility, because data should be available wherever one is. It also makes possible to take care of building even when not near it. They provide new ways of working, which was seen also important. These ways of working also provide better monitoring of service providers and the interviewees pointed out that also they should be made familiar with these different applications to achieve benefits from them, otherwise mobile applications are pointless. The interviewed companies had done this and they are very keen to listen their opinions to develop the FM software, so that the number of collaborators would rise even more and different opinions were heard when developing them.

Still, mobile applications are only a supporting feature to FM software. Although they simplify and improve effectiveness. University properties in Finland Ltd pointed out, that one big obstacle rises when the service provides themselves do not develop the know-how of their employees. This would lower the threshold to use mobile applications, because according to them "*There seem to be a lot of prejudice."* They thought that the more they are used, the more ideas are brought up which advances the development.

In Vantaa's point of view, mobility has especially eased the lives of facility managers. The ways to measure spaces and their utilization efficiency, in addition with making and checking service audits. Auditing itself is also much more efficient, when one can instantly register audits into the system without the need to mark the results on paper first.

DNAs main users did not use the mobile versions so much, but their contract parties used it all the time, and were one of the main reasons why they did not abolish the feature in their processes due to the extremely positive feedback that they got from it. Thus, they moved it onto its own platform so that it could service them better. They see that the usage between mobile applications and traditional desktop versions is going to dim in the future. The only barrier is the under-development of mobile applications, which need to be taken into special account in future development by service providers.

7.7 Future development

Most of the development ideas and fields were linked to sustainability. All agreed that maintenance management is going through a turning point, which is caused by increased interest in sustainability and mobility, digitalisation and the importance and the amount of reliable and functional data. Digitalisation and mobility go hand in hand and are key factors when thriving towards more usable spaces, adding the value for occupiers and improving factors that make spaces more wanted. In addition, indoor air condition and functional spaces, with the increased amount of vacant spaces were seen as problems. Therefore, it's also a matter of competition: the service providers that can match these criteria are will thrive according to interviewees, whereas others will likely drop out and fade out. Interviewees also thought that it they also have responsibility to develop this things by bringing out development ideas and their own opinions to attention of the developers of FM software.

Users and owners are even more keen of knowing what happens in their buildings. Therefore, monitoring all actions is a factor that the interviewees thought that would increase in the future. Because metering no longer needs huge amount of cables because of wireless systems, it is now even easier and cost effective than before. Still, the key is to make invest to improve these conditions. They also pointed out that although investing is a key factor, they don't do anything, if actions are not done according to data they receive. Citycon Ltd also pointed out that derivative action could be a key factor to lower emissions. For example, it is possible to optimize heating and cooling that gets its data from weather forecasts and through that data it optimises cooling and heating accordingly.

The greatest challenge is how the software developers, real estate owners and interest groups how to adjust to the change, what actions are needed and how they collaborate to make the best possible outcome of it. The need that the processes are compatible with each otherDue to aging of the working population, the overall IT skills are going to rise in the future. This

allows the overall processes to step up, when old ways of working and processes are faded out and replaced by new ways. This emphasizes the meaning of CMMS and other processes and grows their market and importance. Because all in all FM is a field of service.

8 Reliability of the research and proposal for further research

This chapter analyses more thoroughly the reliability of the research and what factors have affected it. Lastly it presents possibilities for further research.

8.1 Reliability and validity of the research

Essential part of every research is its reliability and validity. Reliability means the accuracy or repeatability of measurements, whereas validity means competence of the research, i.e. the capability to measure exactly what is meant to be measured. These two factors are usually linked to quantitative analysis, but they can also be used when evaluating qualitative research. (Hirsjärvi et al. 2006, p. 226-228) The main factor for boosting the reliability of the research is to provide an in-depth description of execution of the research, in addition with exact report why one has gotten into these results. Consistency is a key factor in qualitative analysis. (Hirsjärvi et al. 2006, p. 226-228) This research was done accordingly to earlier mentioned factors: it's mission was to provide an accurate and consistent report how the research was done and why these results were accomplished to maximize the validity and reliability of the research.

Interview questions can be seen to fulfill the task to enrich the research and thus to increase its reliability and validity. These methods were used also in this research when possible, and all the quotes that were achieved in these interviews are written with permission to this thesis.

In qualitative analysis validity can be interpreted as the credibility and plausibility of the research, which culminates in how the researchers' deductions match the statements that the interviewees give and how well the researcher can interpret them to others. (Hirsjärvi et al. 2006, p. 226-228) Understandable interpretation of the answers from interviews was also a crucial task in this research, in addition with providing comprehensible interpretation from the collected data from different markets. One problem in the interview survey is the interpretation possibilities, because the interviews were not recorded, which would solve the problem. On the other hand, this provided that the interviewees were acting more freely in the interview situation which provided more data due to lack of restrictions. After the interviews the interviewer went through the interviews and wrote the notes in-depth in order the avoid remembering incorrectly.

As in every interview survey the number of interviewees and the size of the material can be questioned. This research could have had more interviewees, but because of the carefully limited criteria of possible interviewees was narrowed in addition with the quantitative data analysis, the amount of XX interviewees was thought sufficient. The sufficient number of interviews is achieved when new interviewees do not provide any new thoughts and data to the research and this was achieved in the research.

It was crucial to the research to have interviewees, who had worked a lot with CMMS but they also had knowledge how it affected in their company and what benefits they achieve from CMMS. This means that the interviewees should be in high position in their companies, so they understand the fundamental advantages that CMMS give to their company and how much cost savings they achieve. It is also good to remember that although the answers are

partially subjective may thus vary, in addition with the influence of the certain company's policy.

The interviewer also has great responsibility not to affect to the research outcome and not to guide the interview situation too much, but sometimes this might be challenging, because the interviewer must keep the conversation flowing. This might lead in prescriptiveness, because the interviewer can comment on the answers or lay foundations to the questions. This could have been prevented with better setting of questions, but some of the problems arise when the concepts weren't familiar to interviewees. There was also some repetition in the questions, due to different kind of CMMS usage that the case companies have.

8.2 Further research

This thesis worked as a groundwork, where maintenance costs were reviewed in different countries and what reasons affect to them. Secondly their functions, what are most important in computerized maintenance management software to reduce costs and support the most company's core functions were analyzed. This was the first research, that clarified the differences between maintenance costs and added information about the cost savings that CMMS give to real estate owners and how they support their core functions. It provides many options for further research, where the greatest would be the maintenance cost comparison. Due to insufficient data, the maintenance cost comparison is very superficial and there aren't many instances that research maintenance costs in depth. There are a few reasons to this: in requires massive amount of work to gather the data from different real estate owners and furthermore to analyze this massive amount of data. Secondly, real estate owners are not very willing to give such specialized data, because it also requires massive amount of work from them to sort out the data. This is a harm, because it should be presumption that companies would monitor that kind of data. Thirdly, some regions have just started to wake up to the fact, that there is also possible to save energy in their buildings, due to the great construction booms. In my opinion, this would be the greatest single research option, that could be conducted. Due to the lack of data this research only consisted from office buildings in prime locations, but the further research should also cover retail, warehouse and factory premises, in addition with hotels and hospitals. This is required to cover maximum amount of different kind of premises and get more relevant data about the variance of maintenance costs.

Another option for further research is to deepen into different regions, their managers and how they use CMMS, where facility management software are partially new subject and information about them are hard to obtain. Especially China and UAE are areas, where the construction boom has been exceptional over the last decade and more, which would provide a great amount of various data to analyze and different kind of usage groups for CMMS. This would provide different kinds of insight over the key factors in CMMS and its usage, but also different kind of analysis over the savings potential, do to different kind of real estate stock. CMMS could also be researched in the view of maintenance experts, what kind of features they value the most, or in the viewpoint of occupiers: have they noticed any changes after the owner has started to use such software and have they gotten any added value from them. The interviews also pointed out different kind of problems in real estate field, which have been separated in chapter 5.1.4. They also provide excellent options for further research to both companies and universities. In addition, energy saving was pointed out many times in the interviews, in addition with mobility and SaaS-services.

As a conclusion, maintenance costs and effects of CMMS to them is a subject that has not been researched a lot, only by case studies and there can be seen demand for research that would broaden the information regarding them.

9 Conclusions

Facility management software have a lot of challenges ahead of them, but currently their situation can be seen solid regarding their usefulness and overall performance compared to traditional methods. And as the interviewees stated, it is hard to think working without them and still maintaining the high service level they promote in their own actions.

As the world has become more data oriented, there is a dire need for accurate data and this can be only by collecting it, both by individuals and companies. The biggest challenge in this thesis was the amount of data: there are very few companies that collect occupancy costs from different cities / countries with enough accuracy that it could be used. A single number from certain city without telling what does it consist of is not useful and cannot be used for a thorough analyzation. There should be enough data crunching and specification between different sub-parts of occupancy costs: how big portion does energy consumption take in the overall costs, how does taxation affect and are repairs calculated to the results or not, for example. Without these key factors, the numbers are nothing but a top of the iceberg, and do not advantage real estate owners itself. Both the real estate owners and service providing companies are responsible for this to happen. Facility management software itself can collect and analyze the data, but all the other factors (usage costs, taxation, cleaning, repairs etc.) could be added to it, to gather whole coverage of occupancy costs and what they consist of. One of the biggest advantages that were mentioned in the interviews were reports of different aspects from their real estate and this could be another added factor to facility management software.

Auditing and sustainability were also seen as big factors now and in the future especially. Sustainability is mostly about preserving the future, but it is also a brand question to companies. Because facility management software is compatible with auditing tools, it would be possible to enhance sustainability, by providing the possibility to obtain certificates, such as LEED, in it, to provide more efficient tool to validate if a certain building can get a certificate. But, in the end, sustainability is not about certificates, it is about actions to reduce and maintain lower consumption and emissions and to secure reasonable life cycles to buildings.

World is going towards open data. This is crucial for facility management software business. Nowadays the data gained is secure and real estate owners do not like to give out valuable information about their buildings when it is not necessary. Still, could big data change all this? When data becomes even more available everywhere, it could change the need for CMMS in general and they would have to adapt into changing culture. If data can be achieved from everywhere, what is the function of facility management software? Real estate owners use a lot of resources, both time and money, to upkeep and develop facility management software on their own, but if data would be open to everyone, it would be possible that maintenance service providers could provide analyses of their own with minimal effort. This would allow real estate owners to allocate their resources to other processes.

But this calls for expertise, which was discussed in chapter 2. It is seen as a good practice to have a designated manager to handle properties to maintain its condition and to develop in collaboration with owners' guidelines. Therefore, if maintenance companies would upkeep all the facility data in their own software and giving out the reports, crushed data and other

important details, would it be better than the current situation? Because even maintenance needs maintenance itself, and it requires expertise to know how to operate these systems. Sure, there is a certain call for more agile and lightweight software, but when moved towards a more sustainable lifestyle, it also requires expertise to know how to manage to do that. In Scandinavia, the situation is taken into account extremely well, but for example in China, which is developing country in many factors, there are still many things to take into account, but thankfully the government has begun actions towards a more sustainable living, for example when reducing coal usage in electricity.

It all comes down to advantages and added value. Interviewees stated, that the greatest advantages come from efficiency, accurate reports and data, scheduled maintenance that can be controlled and the availability to obtain all the information in one place. Still, as mentioned before, facility management software only gives you out the information and makes it able to control it, but it's about the owner, the managers and the service providers how they use it. This is a situation for expertise and collaboration, so that all the participants know how to manage real estate. Finnish Properties Ltd pointed out, that one of the biggest development targets would be to develop the expertise of service providers, but this has caused prejudice and has not been so easy to obtain. But, they also stated, that if one does not develop, they are left out, due to bad reputation and incapability to do tasks that are agreed. On the other hand, mobile applications were greeted with joy, which makes a slight conflict in the process: why normal activities and overall developing oneself is thought as hard and bad, but mobile applications are not?

Mobile applications and hardware are part of development and the field is going towards to them in addition to ease working, but still it seems that they are only a supporting part of the process and at least not taking over traditional desktop applications. This is result from the massive amount of data and the incapability of applications to provide same features. Still, remote systems are here to stay and they have revolutionized energy metering.

The aim of this research was to answer following three research questions by interview survey and literature review, the first question was:

1. How real estate maintenance costs vary in Scandinavia, Middle East, Spain and China?

It can be said, that the overall maintenance costs are pretty much equal in the Scandinavian area, excluding Norway which has the same level as Spain and UAE. China is on its own league, exceeding all the other areas that were taken in this research. No single factor can be stated what causes this, although there seems to be a certain connection between higher rents and higher maintenance costs. This is usually the result of higher service costs and wage costs due to the amount of staff working in a certain premise.

2. What kind of savings the computerized maintenance management software can cause to maintenance costs in the selected markets?

None of the interviewees could not state how much they have saved in maintenance costs by numbers. They have used CMMS for so long that they do not have any data regarding them, or they have just started using them, so they haven't registered anything regarding them. Nonetheless, the are several factors that cause savings when CMMS is used: more efficient

working tools, time saved, savings done when maintenance is done accordingly and all parts are working and the core process functions correctly, the needed number of workers then CMMS takes care of processes, the possibility to monitor energy usage and decrease it and the unavailability to handle their processes without them. The amount of energy saved could not be acquired from interviewees, but they stated clearly that CMMS saves energy, they just have not monitored the amount.

Research question 3:
What features do real estate owners seem to value in facility management software?

Real estate owners value different things, but in general can be said, that the most important functions are reporting possibilities, so that they get accurate and real-time data from their premises, which ease their decision making, possibility to report to management and to act into processes, that are not working accordingly. Especially long term planning, maintenance calendar and maintenance audits, in addition with energy metering and document bank where the most important sections, that they use and value. Mobile applications, auditing and contract banks, in addition with budgeting were also thought useful, but weren't valued as high as the earlier mentioned sections.

Overall can be said, that this thesis calls for further research in many sections: how can CMMS add even more value to users and real estate owners and what are concrete actions to do so, the need to gather even more adequate maintenance cost data in different countries and how to utilize it, how CMMS could be used to utilize that maintenance data for more in-depth analysis and how it could be a key figure in IoT and automatization in the future.

10 Summary

The object of this thesis was to find out what is the maintenance cost level in different regions, how they differ and what is the savings potential through FM software, what kind of advantages they produce and how much savings do they give. The problem is important due to lack of studies globally, sustainability being an even growing value in the field and the amount of emissions and consumption caused by buildings. Real estate's account for 40 % of energy consumption and 30 % emissions in the EU (INREV, 2015) so it's important to reduce them and figure out how CMMS can help in this.

Facility management is relatively new field of study, and it has traditionally been linked to maintenance. Maintenance can be done in different ways, which are preventive maintenance, corrective maintenance and opportunistic maintenance, the latter being the newest way, whereas corrective maintenance is the traditional way: you fix something when it is broken. Nowadays maintenance has turned into even more opportunistic. You repair subjects before they are broken and hopefully find other targets that are in the need of repair, which increases cost-effectiveness (Lind & Myingo 20xx p. 17). Facility management itself is much more than traditional maintenance: it is a profession that that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology. (Cotts, Roper & Payant, p. 4) Property management on the other hand controls the usability and value development of certain real estate. This requires technical and organizational skills in addition with co-operation with the real estate owner. (Kyle et al 2000, p. 13)

There are many tasks that enhance the condition of the real estate, but the best way to keep track and update it is long term planning. To figure out the steps that need to be done, the building needs condition survey, if it isn't a new building. Condition survey consists of the following steps:

- Checking the condition assessment report
- Performing the necessary condition surveys
- Complementing the condition assessment report into long term plan
- Defining maintenance charge.

Long term plan proposal provides then the framework where large repairs and replacements are done in the following years. It provides the repair and renovation schedule for construction technology, HVAC technology, electricity, elevators and building automation. (RAKLI 2012, p. 38)

Facility management software, or computerized maintenance management software, are made for controlling building, mainly from a technical aspect, but they are also much more. CMMS are nowadays produced as a SaaS (service as a software) due to the lack of need in-house staff and its easiness. There is no need to upgrade it regularly, because the software is already hosted and upgraded. Facility management software have traditionally been just a maintenance book, but nowadays they have vast load of other features: in addition to document bank and maintenance plan they can be used for auditing, service audits, energy metering, long term plans and contracts, even billing. The overall amount of information in

facility management has grown rapidly and CMMS is excellent tool of keeping it all in same place. It works as a tool for the board members, property management, maintenance personnel and even occupiers.

Facility and property management in general is a wide subject, where suitable tools and expertise are keywords for succeeding in it.

Maintenance costs in general consist from different factors: administration costs, usage and maintenance costs, outdoor maintenance costs, cleaning costs, heating/cooling costs, water and sewage water costs, electricity costs, waste disposal costs, insurance costs, rents, other maintenance costs and repairs. They do differ from various reasons: all the buildings are different, climates are different, cleaning isn't done in same procedure et cetera. Therefore, they vary in different regions also. In general, maintenance costs in Scandinavia were pretty much the same, but the legislation (taxes, mostly), make the differences. Also, it can't be said exactly what kind of buildings these prime offices really are, because the definition isn't so clear.

This thesis consisted from two separate empirical sections: how maintenance costs differ in different countries and from an interview survey regarding facility management software. The overall maintenance costs are pretty much equal in the Scandinavian area, excluding Norway which has the same level as Spain and UAE. China is on its own league, exceeding all the other areas that were taken in this research. There isn't a single factor which could be said that causes these differences, however there seems to be a certain connection between higher rents and higher maintenance costs. This is usually the result of higher service costs and wage costs due to the amount of staff working in a certain premise. There is a dire need for larger amount of data available from these countries, where Finland was the only country that provided accurate that could be used into this thesis. However, it could not be used to straightforwardly to compare it to others, due to the inadequacy of the data from other countries.

The interview study proved to be more fruitful, providing insight from following subjects: facility management software usage (what processes they use and how), key function support, cost saving opportunities in maintenance costs and energy, added value from facility management software, usage of mobility and future development. The interview study was done by interviewing five different persons, that worked in a delicate position in their company: they had to had the knowledge about how their company uses facility management software, how does it affect to their company and how their partners and service providers use it. Maintenance audits, document banks, long term planning, energy metering and service audits where thought as the key functions in the software, with the possibility to integrate them to other applications. Greatest key function support functions were obtained from maintenance audits, long term planning and reports that they obtain from accurate data they receive from software. This was one of the greatest features that give them added value, in addition with swifter processes, replaced old systems, lessened amount of required workforce, real time metering of energy and the possibility to react to processes that aren't working accordingly.

Interviewees thought that mobility is going to raise its head even more in the future, and especially service providers thought that it is a great thing to have, because it has eased their

job plenty. Still, the need for desktop version is still dire, because it offers functions and overall interface that mobile applications can't match. Future development is also going this way, and additions to IoT and remote monitoring were thought to be key functions in the whole facility management area.

These findings can itself be used to overall development of facility management and CMMS, but it also rose various questions and need for future development, especially in the point of sustainability, maintenance cost data and mobility. The research area itself was extremely wide, covering maintenance costs and CMMS, and those both could be focused on more specific level covering only a minor detail from them. This research helped to spot risks and challenges that the field of real estate has, and how they could be solved in the future.

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Appendix 1: Occupancy cost comparison

Occupancy cost comparison	Prime rent current	multiplier	occupancy	real		Occupancy costs, office €/sqf/m	€/sgm/m	€/sqf/a	€/sqm/a
Finland	444	1.0	554.4	110.4		99.06	9.20	1188.77	110.44
Sweden	5400	9.2	6500.0	119.1		106.82	9.92	1281.79	119.08
Norway	4250	9.4	5078.0	87.8		78.78	7.32	945.40	87.83
Denmark	1700	7.4	2535.0	112.1		100.59	9.35	1207.10	112.14
UAE	280	0.4	340.0	154.3		138.41	12.86	1660.93	154.31
Shanghai (Pudong)	6120	7.4	9228.0	422.3		378.84	35.20	4546.12	422.35
Shanghai (Puxi)	4744.8	7.4	7409.5	362.2		324.85	30.18	3898.17	362.15
Spain	246	1.0	330.4	84.4		75.67	7.03	908.04	84.36
Average						162.88	15.13	1954.54	181.58
Median						103.70	9.63	1244.45	115.61

Appendix 2: Interview survey questions

Interview background of master's thesis "Differences between real estate maintenance costs in Scandinavia, Middle East, China and Spain - The savings potential through facility management software"

Interviewer:
Otto Pesola
+358 (0)40 6434 358
otto.pesola@granlund.fi

Interviewee:
Name:
Company:
Position:

Questions to guide the interview

1. Usage of facility management softwares
    a. What features do you use in facility management software
    b. Which features have helped you the most
        i. Why?
    c. How do you use these different kind of processes?
2. Do you think that facility management software's give your firm advantage?
3. Can you estimate how much facility management software have saved you in
    a. Occupancy costs
    b. Energy consumption
        i. Heating/cooling
        ii. Electricity
        iii. Water
4. What do you think are the greatest advantages in facility management software?
    a. How have they helped your company?
    b. What development proposals do you have?
    c. What do you value most in these advantages and why?
5. Added value in CAFM software (computer aided facility management)

    a. what kind of added value you get in facility management softwares?
    b. What factors do you think are the most significant?
6. Mobility
    a. Have mobile applications helped your ways of working?
    b. Have they brought you any development proposals?

Haastattelun taustaa diplomityöhön ”Differences between real estate maintenance costs in Scandinavia, Middle East, China and Spain - The savings potential through facility management software”

Haastattelija:
Otto Pesola
+358 (0)40 6434 358
otto.pesola@granlund.fi

Haastateltava:
Nimi:
Yritys:
Asema:

Kysymykset ohjaamaan haastattelua:

1. Kiinteistöjen ylläpito-ohjelmistojen käyttö
    a. Mitä ominaisuuksia käytätte ko. ohjelmistoista
    b. Mitkä ominaisuudet ovat auttaneet teitä eniten
        i. Miksi?
    c. Miten käytätte näitä eri prosesseja?
2. Uskotteko että saatte ylläpito-ohjelmista etuja?
3. Osaatteko arvioida paljon ylläpito-ohjelmistot ovat säästäneet teiltä
    a. Ylläpitokustannuksista
    b. Energian kulutuksesta
        i. Lämmityksessä/jäähdytyksessä
        ii. Sähkössä
        iii. Vedessä
4. Mitkä näette olevan suurimmat hyödyt kiinteistöjen ylläpito-ohjelmistoissa?
    a. Kuinka ne ovat auttaneet yritystänne?
    b. Mitä kehitysehdotuksia teillä on niihin liittyen?
    c. Mitä hyötyjä arvotatte eniten ja minkä takia?
5. Ylläpito-ohjelmistojen tuottama lisäarvo?
    a. Minkälaista lisäarvoa saatte ylläpito-ohjelmistoista?
    b. Mitä pidätte näistä tärkeimpänä?
6. Mobiilisuus

a. Ovatko mobiilisovellukset helpottaneet työtänne?
b. Onko teillä niihin kehitysehdotuksia?